Ministry of Education
Ontario

Hon. Bette Stephenson, M.D., Minister
Dr. H. K. Fisher, Deputy Minister

Curriculum Ideas for Teachers

1980

This support document to *The Formative Years*, one of a series dealing with the conservation of energy, provides information, student material, and suggestions to teachers for presenting this topic in the Junior Division.

Water and Energy

Energy
J1

Wave Image #22 (detail), acrylic on canvas,
a painting by Ron Bolt ©

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Introduction

The chemical formula best known to students is H_20. As this formula suggests, water is a very simple chemical compound made up of two parts hydrogen and one part oxygen.

Approximately three-quarters of the earth's surface is covered with water, most of that being salt water. Water is one of the four basic elements needed to support life. The human body requires about 1 L of water per day to carry on its normal biological processes.

An important property of water is that it is a renewable resource. This property is explained by the hydrologic or water cycle. The water cycle consists of three basic parts – evaporation, condensation, and precipitation. The sun heats the water, causing evaporation; the water vapour rises and condenses, forming clouds; the water then falls to the earth as precipitation in the form of rain, snow, hail, or sleet.

While water is on the earth, we use it in many ways. It is a basic need for life, and it is also essential for many facets of manufacturing, processing, and delivery systems, and for recreation. As we use water, we add many wastes to it. Some wastes can be cleaned by natural processes. However, quite often too many wastes are added to the water. This overloads the natural cleansing process, and the water becomes polluted.

Students should consider carefully how they use water. Frequently water is taken for granted and thus often wasted and misused. The activities in this document are designed to rectify this problem.

Students should also recognize that it requires energy to bring water into our homes. Once in our homes additional energy is used to heat the water. In considering their use of water, students should come to see the related use of energy at various points in the water systems.

Water should also be considered as a carrier of energy. Energy can take many different forms (heat, light, sound, electricity, etc.) and may be considered as potential or kinetic in nature. In this sense, all mass contains potential, or stored, energy. If an object is moving, it has kinetic energy, or energy of motion. Thus, water contains potential energy and may contain kinetic energy if it is moving. Although water is not really a form of energy as is light, it is a medium in which energy can be stored.

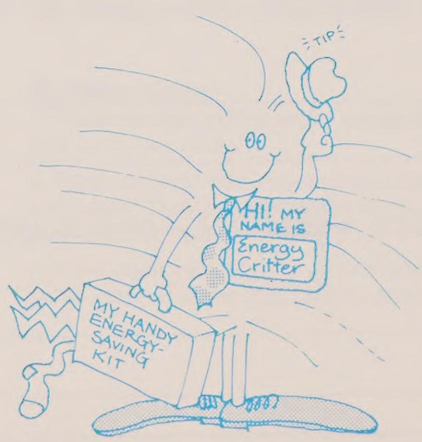
The energy in moving water can be harnessed to make things move or turn. Consequently, moving water is used to make turbines turn, which gives us one of our most useful energy sources – electricity.

Students should also observe that energy is used to transform water from one form to another. The best example is the heating of water to form steam, which was a very important source of power several years ago.

In completing the following activities, make safety a prime consideration in choosing the approach used in the classroom. The amount of time needed to complete the activity sets will vary depending on the interests of the students and the follow-up activities undertaken. However, it is estimated that approximately twelve periods of thirty to forty minutes each will be required.

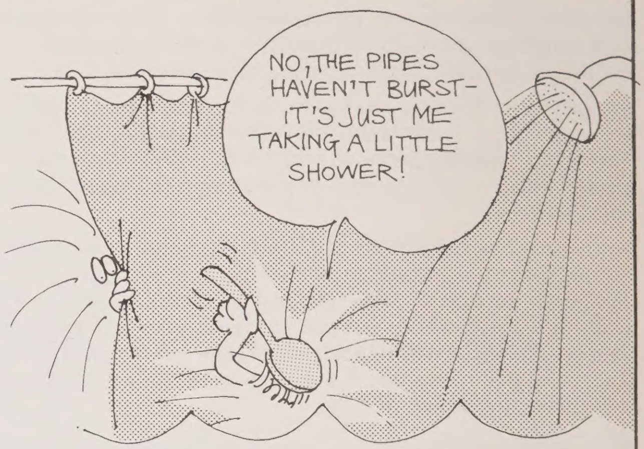
The follow-up activities suggested after each activity set are only starting points. You may expand on these in any way you like. The related ideas that are suggested with each activity set do not always pertain directly to the activity set. They represent further thoughts for consideration when working on this topic related to water.

It is hoped that through these activity sets students will gain an awareness of the importance of water in their daily lives and of the necessity of ensuring that conservation techniques are employed to maintain a consistently high quality of water for human consumption and use.



Name:

How Much Water Do You Use?



1. When you go home today, check to see if there is a water meter in your home. If there is, find it and record the reading on the meter.
Meter reading:__________________

2. When you go home tomorrow, record the reading of the water meter once again. Try to do it at the same time as you did today.
Meter reading:__________________
(Indicate whether your meter is marked in litres or gallons.)

3. How many litres of water did your family use over 24 h?
(Note: 1 gallon = 4.54 L)

4. How many litres of water did you use in 24 h? To find this out, divide the number of litres of water used in 24 h by the number of people in your family.
I used about______L of water.

5. Were you surprised at the number of litres of water you used? Did you think you would have used more than or less than you found that you did?

____

____

6. Were you wasteful with the water you used?__________________
If so, how?

____

____

7. If you were wasteful, how might you conserve water in the future?

____

____

How Much Water Do You Use?

Notes

The purpose of this activity set is to make children aware of the approximate amount of water they use per day. Most meter readings in the home will be in gallons. (This, however, will depend upon the meter type.) Gallons can be converted to litres using the conversion factor 1 gal. = 4.54 L. This activity relies on the mathematical skills of multiplication, division, and the use of decimals.

Figure J1.1: Residential Water Flow Chart

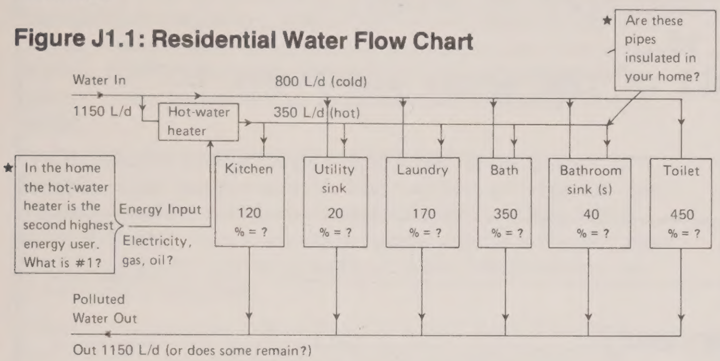


Figure J1.1 is an estimate of the amount of water used by a family of two adults and two children. The 1976 estimated average municipal daily water consumption (residential, commercial, and industrial) per capita in a certain Ontario community was approximately 454 L. The 1976 estimated residential-only daily water consumption per capita in the same community was approximately 227 L.*

Follow-up Activities

1. Have students determine the amount of water used per capita at school per day, per week, per month, and per year. They can make a chart to monitor the water consumption per day over a period of a week, a month, or a year. This same activity could be repeated with the amount of water used per capita at home being monitored.

2. Have students obtain their family's water and sewage bills from their parents if their water is supplied by a utility. They should determine the actual cost per litre of water used. This will provide an excellent opportunity to discuss the relationship of water conservation practices at home to saving money on water and sewage bills. (*Note:* You should have parental involvement before doing this activity.)

3. Students could prepare a chart of the various ways in which water is used in their homes. As well, they could measure or research the amount of water consumed for each purpose. For example, each time the toilet is flushed, approximately 14 L of water is used. The cost involved each time the toilet is flushed could be calculated, based on the cost of a litre of water as determined in the previous activity.

As well, students should be able to rank the water uses, from those that use the most water over a certain time period to those that use the least water.

4. Ask your students to predict when peaks of water use occur during the day, week, and year. Does the city or town employ water-use restrictions at any time during the year? If so, what are they and why are they imposed?

5. Introduce your class to the energy-conservation game "Splash", as follows:

Splash

Splash is an energy-conservation game for the entire class or for the family – from age five to adult. It is easy to play, lots of fun, and, most important, it will help you learn some of the basics of water-energy conservation.

*Statistics supplied by Water Resources Branch, Ontario Statistical Centre.

The game package includes:
1. rules of the game
2. draw-cards
3. markers
4. complete playing surface

All you need to provide is a die. (If you don't have one, use a sugar cube with inked-in dots.)

To make the game-board sturdy and longer-lasting, paste it to a piece of cardboard. Do the same with the markers and the draw-cards.

Rules

1. Each draw-card is either a good or a bad conservation idea. Most cards indicate which is which on the back. A few don't. You, as a group, must decide on those. You must also decide how good or how bad each idea is. Rate each one on a scale of 1 to 10, and mark it on the back. For example, if you as a group think the idea is a minor one, mark it "Advance 2" or "Go back 2". If you think the idea is a major one, mark it "Advance 10" or "Go back 10". Try to use all the numbers. As you learn more about the value of water, you may decide to change the numbers you put on the draw-cards.

2. Shuffle all the draw-cards and place them face up on the table.

3. Each person chooses a marker. Place it to the left of number one – just off the board.

4. Each person shakes the die (use one only) – highest number begins.

5. If you land on a draw space, pick up the top card from the pile and move according to the value indicated on the back. For example, if you land on "3", and the next draw-card is marked "Advance 4", you move to "7". If it is marked "Go back 4", you go back to the beginning and you then have to roll a six to get back into the game.

6. Place the card you picked face down at the bottom of the pile. When all the cards are drawn, reshuffle them and place them face-up again.

7. If you land on a picture, follow the pipe in the direction shown.

8. The first player to reach "100" (a smiling face) wins the game. *You must throw the exact number to win.* For example, a player on "99" must throw a one, and so on.

9. When there is a winner, the other players play for second or third position if they wish.

10. Two or more players can land on the same number at the same time.

Source: Ontario, Ministry of Education, *Energy in Society: A Resource Guide for Teachers* (Toronto: Ministry of Education, Ontario, 1978), part 4, p. 8.

See the appendix for the game-board and draw-cards.

Related Ideas

1. Students may wish to make a tape of the different sounds that water can make.

2. Have students fill a series of test tubes to different heights with water. They can then strike each with a spoon to hear the different sounds that result.

3. Have each student write a poem about water, describing some mood of water (e.g., angry, peaceful).

Name:

The Forms of Water

1. Put 50 mL of water in a saucer. Place the saucer in a place where it will not be disturbed (e.g., on a window ledge). Check the water after 24 h. How much water is left? To find this out, pour the remaining water into a graduated cylinder.
The amount of water left is_____mL.
Where did some of the water or all of the water disappear to?

____

What change of state is this?_______________

What is this process called?_______________

How else can you make water disappear?_______________

At what temperature does water begin to boil?__________ °C

2. Take an ice-cold glass of water and leave it in a warm area for a few minutes. What forms on the outside of the glass?

____

What change of state is this?_______________

What is this process called?_______________

3. Place an ice tray filled with water in the freezer part of the refrigerator. Leave it there for 24 h. What has happened to the water?

____

What change of state is this?_______________

What is this process called?_______________

At what temperature does this process take place?__________ °C

4. Take an ice cube and hold it in your hand. What begins to happen to the ice cube?

____

What change of state is this?_______________

What is this process called?_______________

5. In which of the above activities was heat lost?_______________

In which was heat gained?_______________

Notes

The purpose of this activity set is to have students recognize the changes of state of water and decide whether heat is gained or lost through the processes of evaporation, condensation, freezing, and melting.

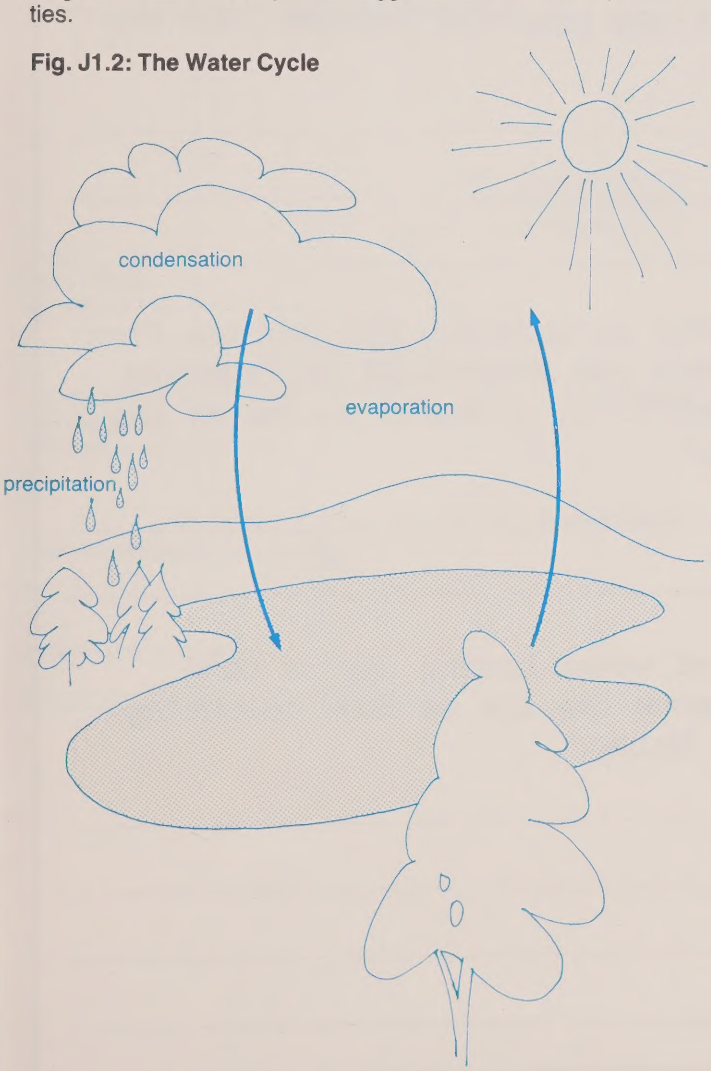
This activity considers water as a solid (ice), liquid (water), and gas (water vapour). Water can be changed from one state to another by adding heat energy or taking it away. Water can change from a liquid to a gas through evaporation. Evaporation occurs naturally and increases as the air becomes drier (less humid). Boiling water also changes water as a liquid to water vapour. This change of state occurs at 100°C (boiling point of water).

The process of water changing from a gas (water vapour) to a liquid is called "condensation". This happens when an ice-cold glass of water is left in a warm area for a few minutes. In this change of state, heat is lost as the water vapour in the air meets the cold glass, thus forming water droplets (condensation) on the outside of the glass.

When water changes from a liquid to a solid (ice), it is said to have frozen. Heat energy is lost in this change of state. The word "freeze" will be familiar to the students. When water in its solid form changes to a liquid, it is said to have melted. Heat energy is gained in this change of state.

Figure J1.2 shows the water cycle. You may wish to reproduce this diagram and give it to the students so that they understand the changes of state involved. They may also make their own diagrams of the water cycle as suggested in the follow-up activities.

Fig. J1.2: The Water Cycle



Follow-up Activities

1. Have students make a diagram of the water cycle and label it appropriately, showing the changes of state involved. Have them also indicate where heat energy is being lost and where heat energy is being gained.

2. Have students verify that the boiling point of water is 100°C and that water turns to steam (water vapour) at this temperature. *Caution:* Please warn children of the danger of boiling water.

3. Have students investigate some of the properties of water. For example:
a) Water expands on freezing.
b) A drop of water acts as a miniature magnifying glass.
c) Some things float in water; others sink.

4. Have students research how water is used to heat homes or apartments by the addition of heat. Make a diagram to show a hot-water heating system. You may wish to invite the school caretaker to come in to explain how a hot-water heating system works.

5. Have students determine how much water is formed when a certain volume of ice melts, or how much water results from melting a certain volume or depth of snow.

Related Activities

1. Have students obtain samples of vegetables or fruits (e.g., potato, apple) and determine their water content. They can do this by first finding and recording the mass of the fruit or vegetable. The fruit or vegetable is then baked in an oven until dry, after which its mass is measured again. The approximate amount of water present in the fruit or vegetable can now be determined.

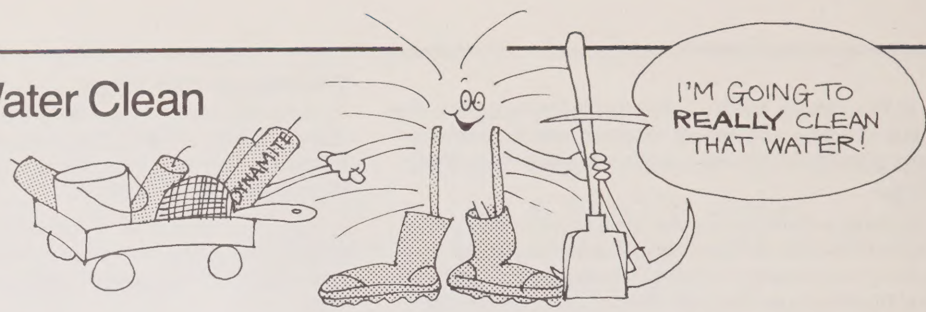
2. Have students draw a diagram to explain how water is used in cooling a car engine.

3. Have students determine the boiling point of other liquids. (e.g., salt water)

4. Have students determine the freezing point of other liquids.

Name:

Making Our Water Clean



1. Take a container of water having some earth in it. How might you remove the earth from it?

____

____

Try your method. Were you successful in removing the earth from the water?________ Would you drink the water now?________
Why or why not?

____

2. Take a container of water having pebbles and sawdust in it. How might you remove the pebbles first and then the sawdust from the water?

____

____

____

Try your method. Were you successful in removing the pebbles from the water by themselves?________ Were you successful in removing the sawdust from the water by itself?________ Would you drink the water now?________ Why or why not?

____

____

3. If you were given a container of water having ink or food colouring in it, how might you remove the ink or food colouring from the water? Write your answer below.

____

____

____

____

Notes

The purpose of this activity set is to have students become familiar with some simple methods of making water clean. Each method requires the use of energy.

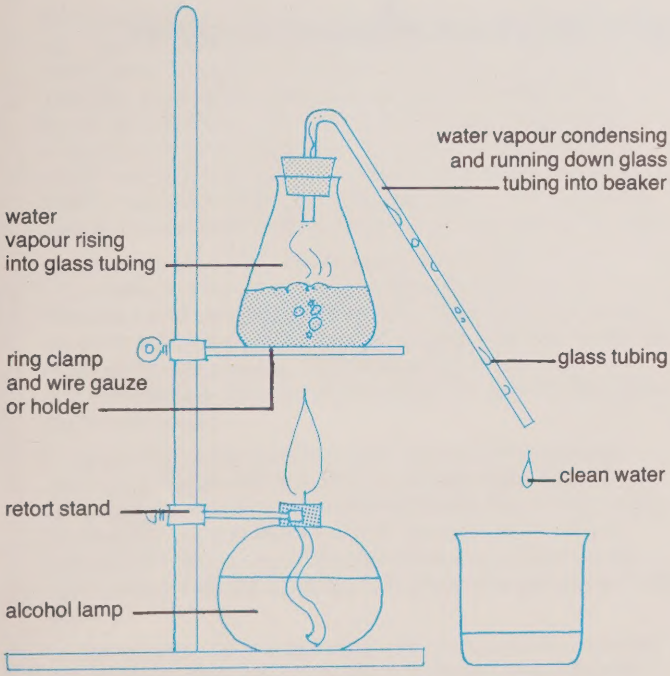
Mixtures of liquids and solids can be separated in many ways. One method is filtration, in which a strainer or filter paper is used to catch the solid particles and remove them from the liquid. In the case of the mixture of dirt and water that the students are given, filtration would be a simple method of removing the dirt from the water.

Another method of separating solid materials from liquids is by settling and decanting. In the mixture of pebbles, sawdust, and water, this method could be employed. The pebbles will settle to the bottom and the sawdust will float on top. As a result, the water with the sawdust on top can be poured off, leaving the pebbles behind. The mixture of sawdust and water can be separated into its two components using the process of filtration.

These are only two of the ways by which mixtures of liquids and solids can be separated. There are many other methods of separation that students may wish to research (e.g., sorting or the use of a chemical additive such as alum).

The process of separating mixtures of liquids is more difficult. In the mixture of water and ink or food colouring, distillation can be used to separate the two components. Figure J1.3 illustrates a simple distillation apparatus which can be set up in the classroom. The distillation process would be demonstrated to the class following the third part of the student activity sheet.

Figure J1.3: A Simple Distillation Apparatus



Distillation is based on the fact that different liquids boil at different temperatures. In this case, for example, the food colouring or ink would boil at a different, higher temperature than water. As a result, the water turns into water vapour at 100°C and rises through the glass tubing, as indicated in Figure J1.3. The water vapour condenses upon reaching the cooler glass tubing and drips out the end into the beaker.

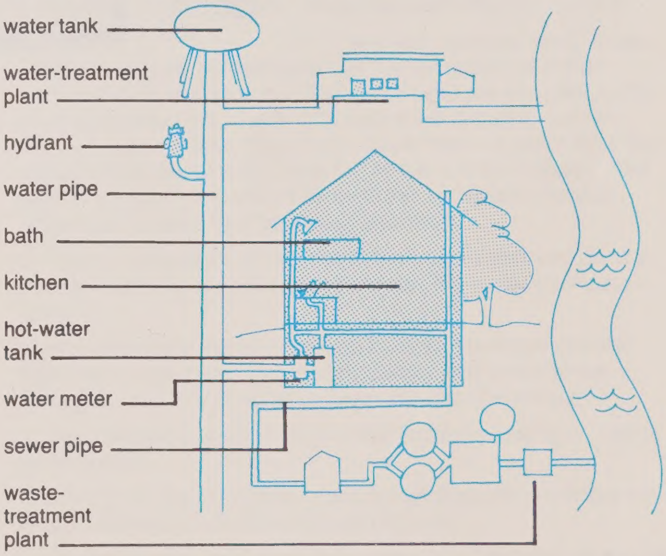
Distillation requires a lot of energy in the form of heat. Thus, it is used to produce only a very small percentage of our drinking water. Bottles of distilled water can usually be purchased from a grocery store.

The process of making the water that comes into our homes potable (drinkable) involves several separation techniques. In the city, the water we use in our homes is returned via sewers to a water-purification plant, where it undergoes various separation processes to become potable once again. (Some general information on sewage treatment follows this section.)

In rural areas, the water used in many homes comes from wells. The water in the wells is usually made potable through infiltration. Infiltration means that the soil absorbs and removes the impurities as the water filters down through it. It is very important that the septic-disposal system of a house in a rural area is not too close to the well for that home. If it is, contamination will result. It is important that water samples be taken frequently to ensure that the water is suitable for drinking.

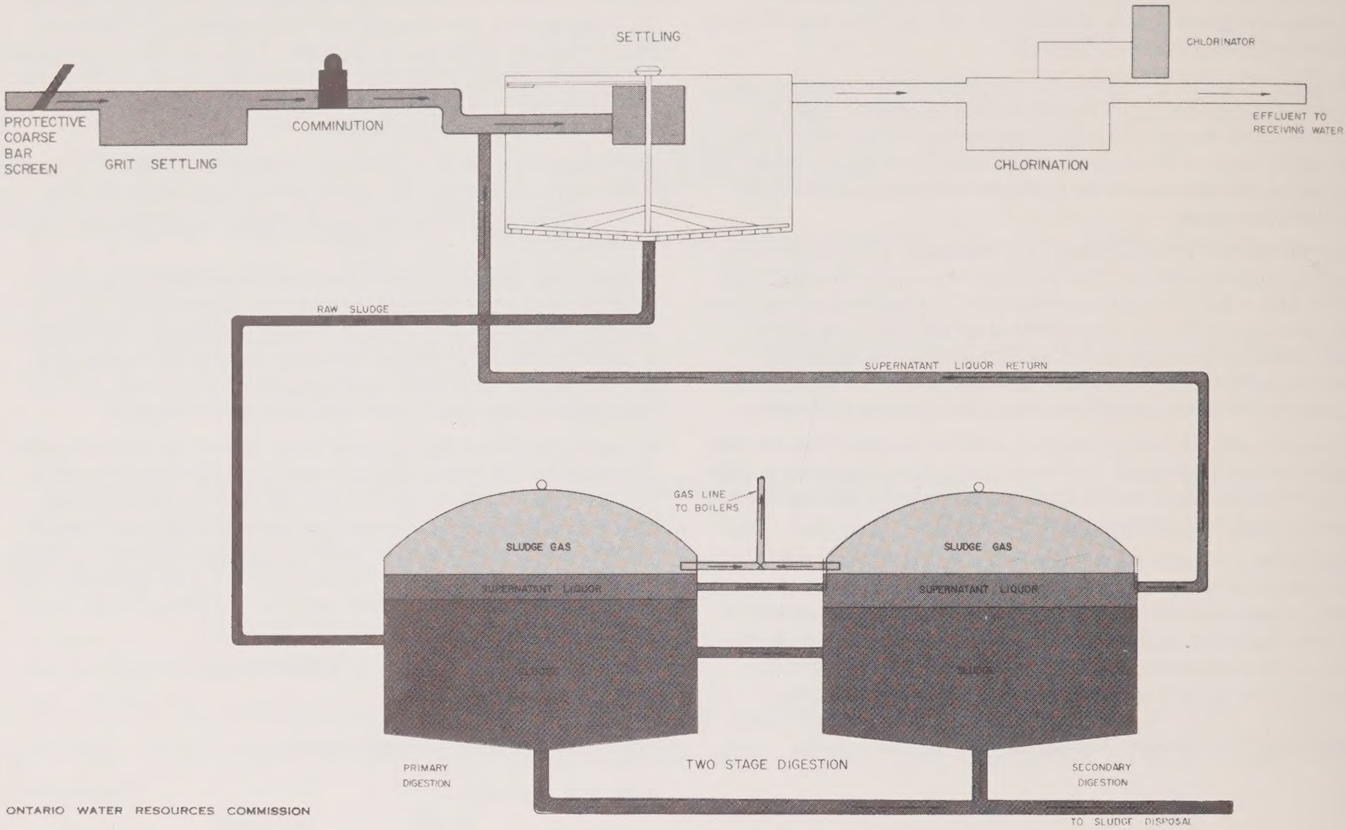
Figure J1.4 illustrates a typical water/sewage system that one might find in a town or city.

Figure J1.4: Water/Sewage System



Source: Adapted from Ontario, Ministry of the Environment, *My Water Book* (Toronto: Queen's Printer, 1968), p. 12.

Figure J1.5: Pollution Control



Source: Ministry of the Environment, *The Water Story* (Toronto: Queen's Printer, 1968), p. 18.

Sewage Treatment

Primary Treatment
Primary treatment is mechanical in nature. Settling tanks are used to remove the settleable solids, floating scum and grease from the wastewater. This form of treatment is used only when it will meet the water quality requirements of the receiving body.

Settling tanks (clarifiers), equipped with sludge and scum removal mechanisms, provide a detention period of approximately two hours for the incoming wastewater. This detention period allows the waste particles to settle to the bottom of the tanks, from where it is removed by pumps for conditioning prior to disposal. The sludge removed is pumped to a digester or other treatment facility, where it is processed or dewatered before final disposal.

Primary treatment usually precedes biological treatment, which is carried out in secondary plants.

To summarize: Primary treatment removes the heavier particles, scum and grease from the wastewater. The effluent produced is of a lower standard of quality than is achieved in complete treatment. The amount of solids removed ranges from 40 to 60%.

Activated Sludge Treatment
The activated sludge process is a method of complete biological treatment which produces a high quality effluent.

This is a secondary process, usually carried out following primary treatment. It removes the finely divided, suspended and dissolved materials remaining in the wastewater.

Biological communities of micro-organisms are developed and maintained in aeration tanks where they are supplied with a plentiful supply of oxygen. The air supply can be provided by compressed air, which is piped directly into the tanks, or by means of mechanical agitators, which revolve and disperse the liquid surface to effect transfer of atmospheric oxygen into the tank's contents. Besides providing dissolved oxygen for the micro-organisms, the air, or agitation, also produces a roll in the tank and prevents settling of solids.

As the organic impurities are assimilated by the micro-organisms, the resulting sludge formation is light and flocculent and can readily be settled. This sludge is the vehicle upon which the bacteria grow and provides the means for maintaining the process. This sludge floc is referred to as activated sludge because of the biological communities growing in and upon it.

Final settling tanks provide the means for removing and reclaiming this sludge floc. As the effluent from the aeration tanks passes through these settling tanks, the settling sludge floc is removed and returned to the process by means of pumps or air lifts and is discharged into the aeration tanks again, along with the effluent flowing from the primary settling tanks.

To summarize: Air is supplied to the micro-organisms which in turn oxidize the finely divided, suspended and dissolved organic materials in the wastewater. This provides a high degree of purification and a clear effluent. The amount of solids removed ranges from 90 to 95%.

Extended Aeration Treatment
The extended aeration process is another method of biological treatment that produces a high quality effluent.

This process is identical to the activated sludge process in its biological application but has no primary settling, and the solids contained in the wastewater are oxidized through an extended aeration period.

Tertiary Treatment
Secondary treatment plant effluents can create some undesirable conditions in some receiving streams through adverse effects on the dissolved oxygen levels, which result in unwanted changes in the living organisms of the streams. Also, these discharges can bring about excess growth of algae and other aquatic plants.

To arrest these conditions, an advanced type of treatment called tertiary is being developed as a third or "polishing" stage to follow conventional secondary treatment processes for the further reduction of organic content. This will improve receiving water conditions as far as the dissolved oxygen levels are concerned. Another important result of tertiary treatment is the reduction of nutrient levels which algae utilize for growth.

No tertiary treatment form is typical. This third stage of cleaning up wastewater must be adapted to the particular need of the receiving water concerned.

Chlorination
Chlorinating facilities disinfect the effluent before discharge from a plant. In most cases a chlorine contact chamber serves this purpose. In this chamber the final effluent undergoes a detention period of 15 to 30 min to ensure good contact with the chlorine. The effluent outfall sewer, running from the plant to the receiving waters, is sometimes used to chlorinate the effluent in much the same way as the chamber process.

From Ministry of the Environment, *Introduction to Popular Treatment Methods* (Toronto: Queen's Printer, 1975).

Follow-up Activities

1. Have students discover how to separate other mixtures of liquids and solids.

2. Have some students obtain samples of water from their homes and from a stream. Have them send the samples to the local authorities (i.e., the health unit) to be tested for use as drinking water. When they return, have them compare the information given about water from the home and the stream. How does the information differ? What is the acceptable level of impurities in water for it to remain potable?

3. Take your class on a field trip to the water-treatment plant in your town or city to observe and discuss the water-purification process.

4. Have students make a diagram to show the steps in water treatment in their city. Have them discuss and label where energy is used in the various stages of water treatment.

5. Have students make a diagram to illustrate water purification by infiltration.

6. Have students compose a spelling list of words denoting the things that make our water dirty or polluted.

7. Have students make a chart to categorize the types of wastes that we dump into the potable water within our homes. Pictures from newspapers or magazines may be helpful in preparing this chart.

Related Activities

1. Have students make a crossword puzzle of the words of things that make our water dirty.

2. Have students place saucers of dirty water (e.g., muddy water, stream water) in the sun or over a radiator. After the water has evaporated, have students examine what is left on the saucer.

3. Have students under teacher supervision make up selected mixtures of solids and water to produce crystals (e.g., salt and water, alum and water, bluestone and water, sugar and water). Have them place the mixtures in a warm place to let the liquid evaporate. They can then examine the different kinds of crystals that are left. Warn students about poisonous or dangerous substances.

Name:

What Is Polluting Our Water?

1. You have heard the word "pollution" many times. What does "pollution" mean to you?

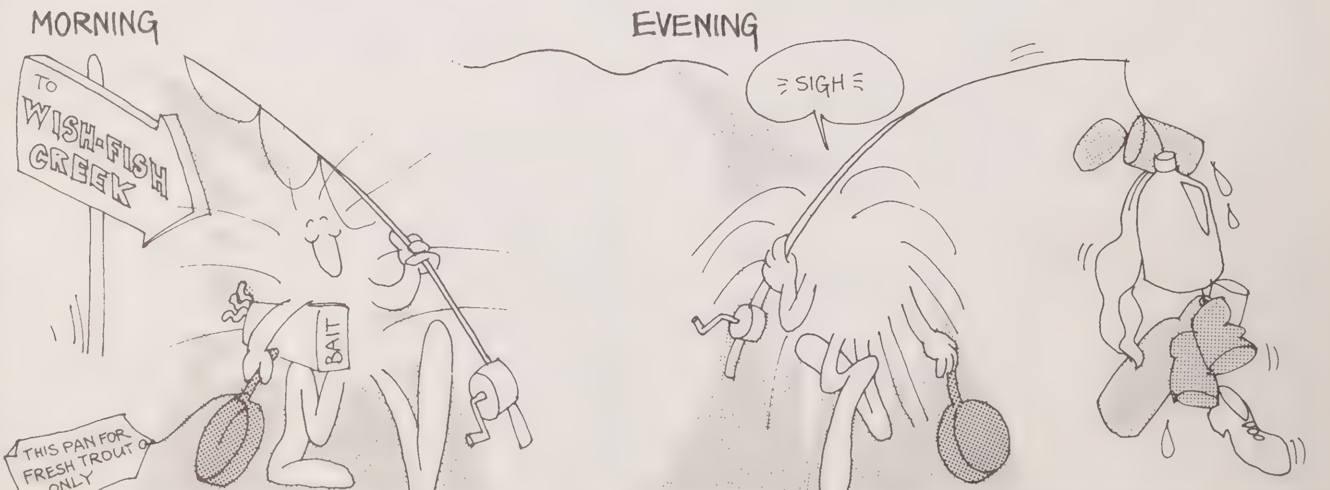
Check your definition of the meaning of pollution with others' definitions. Are they the same?________If not, how do they vary?

2. What do we mean by water pollution?

How do you pollute the water you use in your home?

How do we pollute the water outside our homes?

3. Make a poster showing the ways in which we pollute water. You may wish to add cutouts from magazines to your poster.



What Is Polluting Our Water?

Notes

The purpose of this activity set is to have children recognize the ways in which we pollute our water.

"Pollution" is a term that is used quite frequently nowadays. In its general sense, the word "pollute" means to add foreign materials that cause contamination or produce adverse effects to a medium. When we speak of water pollution, we are talking about the ways our water is being contaminated, thus making it unsuitable for human use without purification. There are many sources of water pollution. Some of these are garbage (cans, bottles), wastes (sewage, animal feces), mercury, thermal pollution of water by industries, and chemicals (fertilizer run-off, acids). Information on water pollution is available from many sources such as the Ontario Ministry of the Environment and Pollution Probe (43 Queen's Park Crescent East, Toronto, Ontario M5S 2C3). Large corporations such as Shell have produced information on how they are trying to combat water pollution (e.g., "Conserving the Environment", Briefing Paper No. 1/72, and others available from Shell Information Service, P.O. Box 400, Terminal "A", Toronto, Ontario M5W 1E1).

Before doing this activity sheet, the students could be asked to bring in old magazines, posters, and newspapers from which they can cut out pictures of sources of water pollution. The student activity sheet suggests a water-pollution poster. The students may make a collage instead, if you prefer. If the poster is chosen, it could be completed in two parts: one part could portray sources of water pollution and the other the ways of combatting water pollution.

Follow-up Activities

1. Have students look at the newspaper each night for a week and cut out any articles pertaining to water pollution. The articles could then be assembled into a collage.

2. Individual students could be assigned research projects on a particular source of water pollution, such as those suggested in the notes above.

3. Have students discuss and research recycling to see how such solid wastes as cans and bottles can be reused.

4. Have students discuss and research other forms of pollution, such as litter, air pollution and noise pollution.

5. Have students prepare a filmstrip to illustrate sources of water pollution, and what is and what can be done to combat the problem.

6. Have students research the problem of removing such pollutants as mercury from water.

Related Activities

1. Have the class organize a "Pollution Week" for the school, during which films on pollution could be shown, puppet shows given, plays put on, a poster contest organized, and so on.

2. Have students prepare commercials that encourage us to keep our water clean.

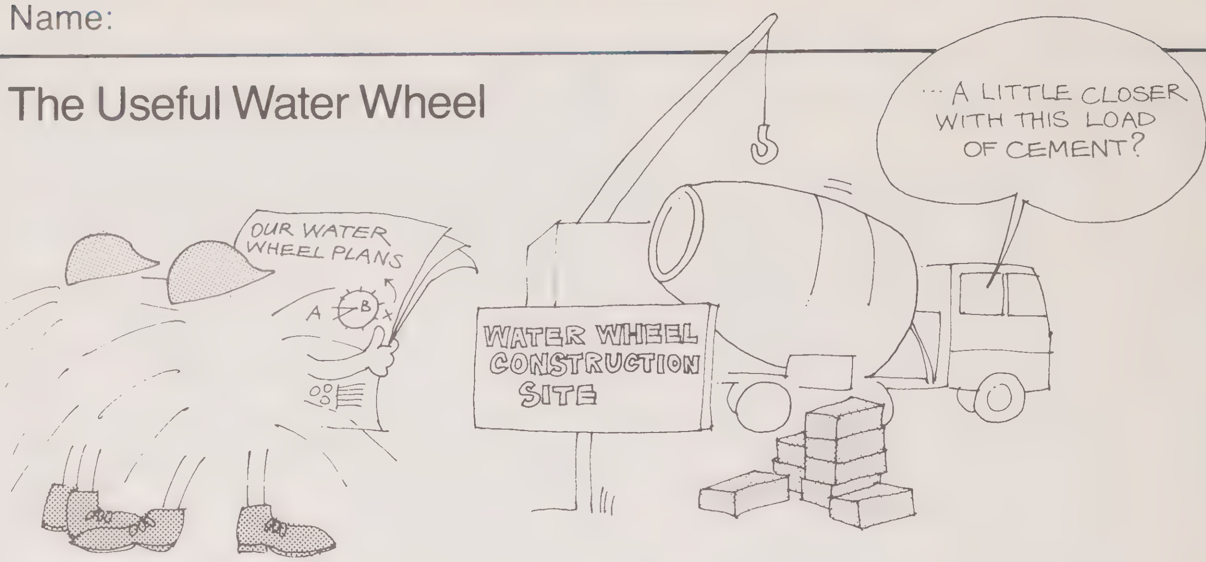
3. Have students prepare posters during art class on how we can keep our water clean.

4. Invite a guest speaker from the local sewage-treatment centre, health unit, environmental control unit, and so on, to talk to your class about the problems of pollution in your area.

5. Have students find out what is meant by "biodegradable detergents" and whether they are used in their homes.

Name:

The Useful Water Wheel



1. In this activity, you will construct a model of a water wheel with a partner. Draw a design of your water wheel on a blank piece of paper, indicating the size of your wheel and the materials you will need. You may wish to use a diagram of a real water wheel from an encyclopedia or some source.

Suggested materials: You may choose to make your water wheel from cardboard, waxed cardboard (milk carton), scrap wood, balsa wood, heavy-gauge Bristol board, or popsicle sticks. You will also need scissors, glue, or staples, and an axle for the wheel to turn on (thread spool and nail).

2. Once you and your partner have constructed the water wheel, experiment with it.

- Turn on the water tap at the sink so it is running slowly and hold the water wheel under the tap. Count the number of times the water wheel turns in 20 s. Answer:________turns in 20 s.

- Vary the height of the water wheel. Does it still turn the same number of times in 20 s?

- Turn the tap on a little faster. Count the number of times the water wheel turns now in 20 s. Answer:_______turns in 20 s. Is this the same as when the water was running slower?_______Why or why not?

____

____

- What should happen to the number of times the water wheel turns if you turn the water tap up to make the water run faster?

____

____

The Useful Water Wheel

Notes

The purpose of this activity set is to have students recognize that moving water is a source of energy and can be used to do work.

The water wheel has been in the past, and still is, a very useful machine. The principle of running water causing a wheel to turn has been used to run grain mills and sawmills in the past. Today, running water can be used to turn turbines, which in turn generate electricity. A scientific explanation of the process of producing electricity is not relevant at the Junior level. However, students should understand that water can turn a turbine (a modified water wheel) to produce electricity for our homes. Running water is, thus, a source of energy which can be made to do work. The energy was produced through the turning of the water wheel.

You may wish to put a maximum size on the water wheel the students are to construct. You may find that the tap in the sink may not be at a sufficient height to allow students to observe what happens to the turning of the water wheel as the height of falling water is varied. If this is the case, you may wish to use a hose outside or find a tap that allows sufficient variation in the height of falling water (perhaps in the caretaker's room). The following is a *sample* set of instructions for making a water wheel:

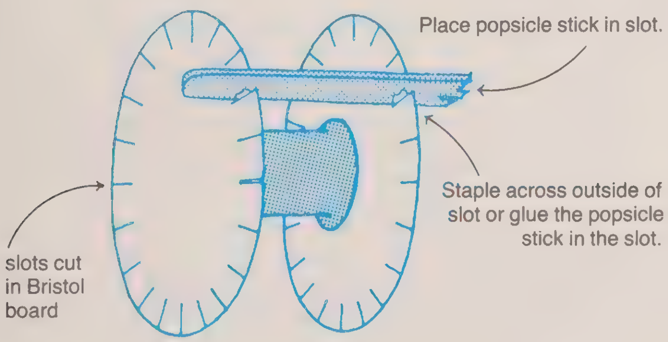
Sample Set of Instructions for Making a Water Wheel

1. Cut two circles each 15 cm in diameter from a piece of heavy-grade Bristol board.

2. Glue or staple the two circles of Bristol board to an empty thread spool so that the spool forms a hub or axle.

3. Obtain 25 popsicle sticks and break them into lengths so that they are about 1 cm longer than the thread spool.

4. Cut slots in the circles of Bristol board so that the popsicle sticks can be placed in the slots to serve as paddles. They should be placed about 3 cm apart around the outsides of the circles. Glue the popsicle sticks so that they will not fall out of the slots. (You may wish to staple the outside of each slot so that the popsicle stick can't fall out.)



5. A long nail can be inserted through the spool to act as an axle for the wheel to turn on.

Follow-up Activities

1. Students may wish to do a research project on the historical use of the water wheel. They could take the water wheel they have constructed and make a model of an old mill (e.g., a saw mill).

2. Have a student bring in a bicycle which has a headlamp run by a generator on it. Prop up the rear of the bike and have a student turn the rear wheel by turning the pedals. When the appropriate part of the generator is allowed to touch the wheel, the students can observe the headlamp of the bicycle light up. This can be related to water turning a turbine, which in turn produces electricity.

3. Have students research how a water turbine is used to generate electricity.

4. Have students research how the underwater "windmill" is used in the case of flowing streams to produce electricity.

Related Ideas

1. Have students find out if moving air could be used to generate electricity.

2. Have students discover the difference between turbine blades and propeller blades.

3. Have students discover what causes a paddle boat to move. Have them make a diagram to show this.

4. As an enrichment activity have students find out in what ways the linear motion of something can be converted to rotary motion (e.g., the underwater windmill is one way).

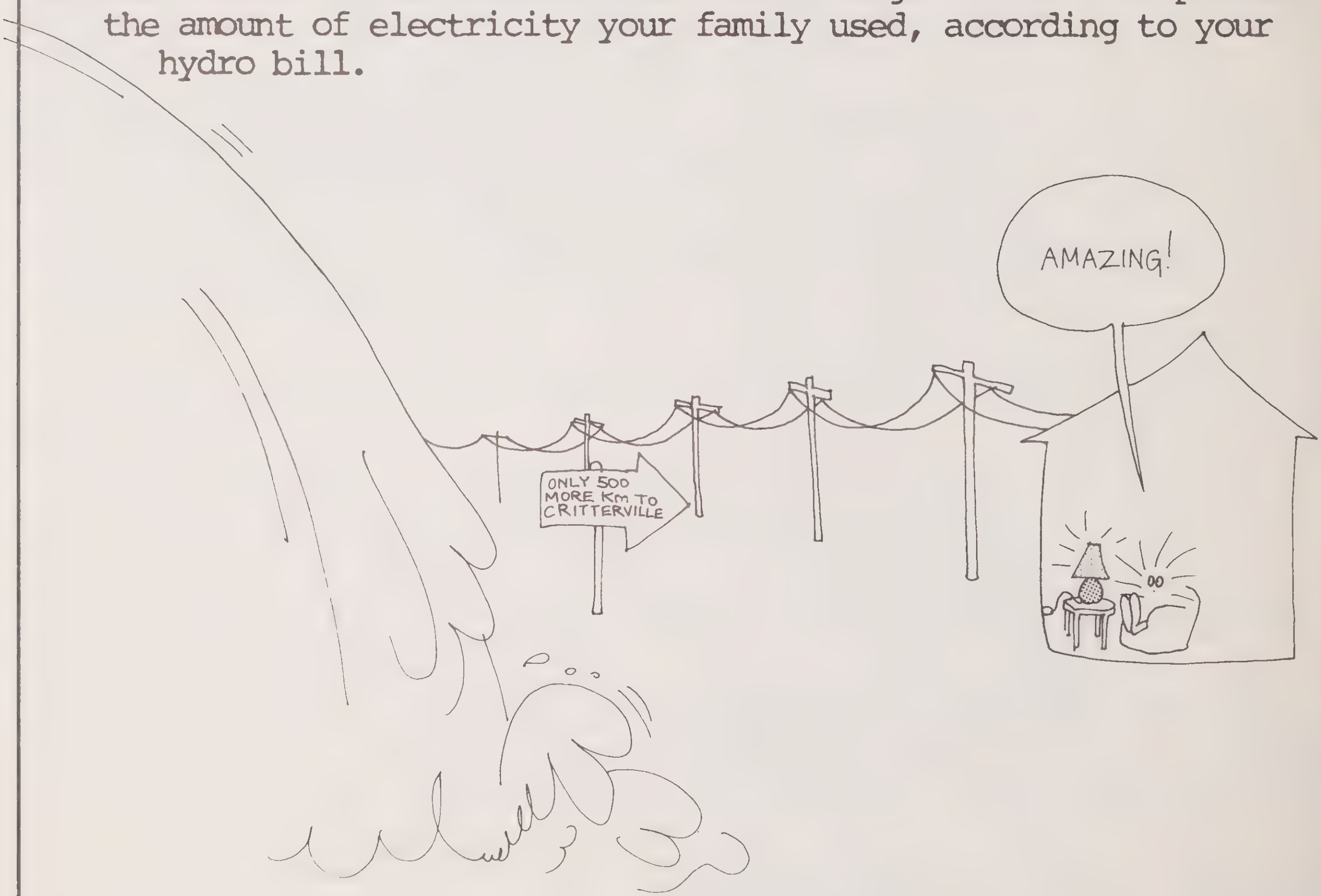
Name:

How Much Water Is Required to Produce Electricity?

It takes about 12 L of water falling 30 m to produce 1 W•h (one watt hour) of electricity. Therefore, to produce 1 kW•h (one kilowatt hour) of electricity, it would take 1000 x 12 L or 12 000 L of water (1 kW•h = 1000 W•h).

1. Obtain from home the last electrical bill your parents received. The bill will indicate the period of time the bill is for, the number of kilowatt hours used, and the charge involved. From the bill, record the following information:
Number of kilowatt hours used is______kW•h for the time period ________________to_______________.

2. From the information given to you above, calculate how many litres of water would have to fall from a height of 30 m to produce the amount of electricity your family used, according to your hydro bill.



3. Calculate the average amount of electricity used per day over the time period indicated on the hydro bill. (Divide the number of kilowatt hours by the number of days.)

4. How much does every kilowatt hour of electricity used cost?

Note: Not all electricity is produced by falling water.

Notes

The purpose of this activity set is to have students become aware of the amount of falling water needed to produce a unit of electricity in their homes.

The reading of the hydro bill is relatively simple. The blank bill (Figure J1.6) gives you an idea of the format of the hydro bill used in most municipalities.

Note: Before pursuing this activity, you should be sure that your students' parents have no objections.

Figure J1.6: Sample Blank Hydro Bill

The Public Utilities Commission of the Township of ....

P.O. Box 00, Your Town, Ontario

Consumption Charge

Account Number

Net Payment Date

Amount Payable on or Before Due Date ....

Amount Payable After Due Date ....

	Meter Readings (kW•h)		
Billing Date	Present	Previous	Consumption

☐ Cash ☐ Cheque

To determine consumption, the previous reading is subtracted from the present reading. In order to determine the exact number of days the bill is for, the student may have to refer to the "billing date" of the previous hydro bill. To determine the cost per kilowatt hour of electricity, the consumption charge is divided by the number of kilowatt hours used.

The information given to the students at the beginning of the activity sheet is approximate. The statement that 12 L of water falling from a height of 30 m produces 1 W•h of electricity can be verified scientifically. Electrical energy is sold by the kilowatt hour (kW•h). Therefore, a device that has a power rating of 1000 W(1 kW) when used for 1 h converts 1 kW•h of electrical energy to other forms. To calculate the energy in kilowatt hours, the power of the device (expressed in kilowatts) is multiplied by the time (expressed in hours), that is $E = p \times t$. A 100 W light bulb left on for 15 min uses:

$$E = \frac{100\ \text{kW}}{1000} \times \frac{15}{60} = 0.1 \times \tfrac{1}{4}\ \text{kW•h} = 0.025\ \text{kW•h}$$

It should also be noted that electrical energy can be calculated in MJ (megajoules). 1 kW•h is the same as 3.6 MJ. Therefore, the 100 W light bulb left on for 15 min would use 0.025 kW•h x 3.6 MJ/kW•h or 0.09 MJ.

Several appliances around the home may not have the wattage specified. The wattage can be calculated by multiplying the voltage by the current of the appliance. For example, in an electric kettle the voltage is 120 V and the current is 12 A (amperes). Thus, the power in watts is:

$$120\ \text{V} \times 12\ \text{A} = 1440\ \text{W or } 1.44\ \text{kW}$$

Nearly everything in our homes uses 120 V. The current drawn is usually stated on the back of the appliance. Several high-energy-consuming devices such as stoves, hot-water heaters, and clothes dryers usually use 240 V. Table J1.1 indicates the average power and energy conversion for residential electrical appliances.

Table J1.1: Average Power and Energy Conversion for Residential Electrical Appliances

Appliance	Typical Power Rating (W)	Monthly Energy Conversion (kW·h)
Cooking and Food Preparation		
Range (standard)	12 500	100
Range (self-cleaning cycle only)	3 200	4
Dishwasher	1 300	18
Oven — electronic	1 450	22
Kettle	1 500	12
Frying Pan	1 150	16
Broiler	1 400	10
Coffee maker	900	6
Hot Plate	1 320	8
Deep Fat Fryer	1 500	7
Barbecue Grill	1 350	5
Food Waste Disposer	450	3
Toaster	1 150	3
Grill (sandwich)	1 160	3
Waffle Iron	1 120	2
Carving Knife	90	1
Food Blender	390	1
Food Mixer	125	1
Can Opener	175	1
Mixer (hand)	100	2
Mixer (table)	125	2
Rotisserie	1 400	2
Incandescent lighting		
Table Lamp (tri-light)	100	8
Dining Room Fixture (5 lamp) Chandelier etc.	300	9
Ceiling Fixture (single lamp)	60	2
Ceiling Fixture (3 lamps)	120 total	3
Fluorescent lighting		
4/ft. single lamp	50	7
4/ft. two lamps	100	15
Miscellaneous		
Clock	2	1
Power Saw	275	1
Floor Polisher	300	1
Lawn Mower	1 500	3
Sewing Machine	75	1
Vacuum Cleaner	800	4
Hedge Trimmer	125	1
Block Heater	500	40
Drill	300	1
Furnace Fan (oil or gas)	250	100
Oil Burner	260	50
Home Entertainment		
Radio — tube type	50	8
Radio — solid state	5	1
Hi-fi — tube type	115	10
— solid state	30	6
Television (black and white)	200	30
Television — colour	330	40
Comfort and Health		
Room Air Conditioner 6 000 BTU/h	935	60-400
Room Air Conditioner 9 000 BTU/h	1 400	90-600
Fan (portable)	115	4
Hair Dryer (portable)	350	3
Heat Lamp (infra-red)	250	1
Heater (portable)	500-1 500	varies with wattage and use
Heating Pad	65	1
Humidifier (portable)	100	10
Shaver	15	1
Sun Lamp	280	1
Tooth Brush	10	1
Dehumidifier	350	15
Bed Blanket	180	10
Laundry		
Clothes Dryer	4 800	80
Iron (hand)	1 000	12
Clothes Washer (automatic)	500	8
Clothes Washer (non-automatic)	300	5
Water Heater	4 500	500
Food Preservation		
Food Freezer (15 cu. ft.)	335	75
Food Freezer (frost free 15 cu. ft.)	425	90
Refrigerator Freezer		
non-frost free (12 cu. ft.)	300	100
frost free (12 cu. ft.)	500	150

Source: Ministry of Education, *Energy in Society: A Resource Guide for Teachers* (Toronto: Ministry of Education, Ontario, 1978), part 3, p. 18.

Follow-up Activities

1. Have students calculate the number of litres of water falling from a height of 30 m required to produce electricity in their homes for 1 min; 1 h; 1 day. Have them estimate how many litres of water would have to fall to produce electricity for their homes for 1 year. (By taking the amount for 1 day and multiplying by 365, an estimate can be obtained.)

2. Have students graph the amounts of electricity used every two months in their homes in kilowatt hours for the entire year. Have them determine and explain peak periods of use.

3. Have students calculate the number of litres of water falling from a height of 30 m required to run various appliances in their homes. To do this, they should first look at each appliance to determine its wattage. For example, the wattage of an iron might be 1100 W. From that, they can determine that the number of litres of water falling from a height of 30 m required to operate the iron for 1 h would be 12 x 1100 or 13 200 L of water (1 W requires 12 L of water).

4. Ask students to conduct a survey of the wattages of all appliances in their homes. As well, have them record the average amount of time (in hours) that each appliance is used during the week and during the year. Have them calculate the amounts of water that would have to fall from a height of 30 m to produce these amounts of electricity.

5. Similar studies to the above can be completed at school.

Related Ideas

1. Have students make a tape of the sounds of water as it falls from various things (a tap, rapids, falls, etc.)

2. Ask students to find out the "side effects" of damming water to produce electricity.

3. Have students collect information about the James Bay project to find out the following information: Where is it? What is its purpose? When was it ready? What effects could it have on the James Bay environment?

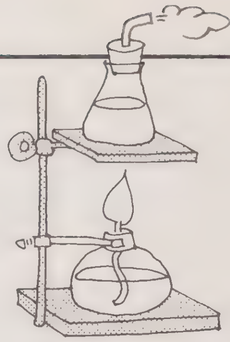
4. Ask students to find out what happens if dams break.

5. Have students find out what factors are necessary to make a site suitable for the production of electricity. Are there any such locations in Ontario?

6. Have students compare a hydro bill from one area with that of another area. (These may be obtained by the teacher.) Do they find any differences in hydro charges from one area to the other? If there are differences in hydro charges, ask students to suggest reasons why.

Name:

Steam Can Be Power



1. Using the equipment illustrated in the diagram at right (or similar equipment), your teacher will assemble a simple steam-generating apparatus.

2. Your teacher will heat the water in the container with an alcohol lamp until it boils. What is coming out of the jet-shaped end of the glass tubing?________________________ Does it appear to be coming out fast?

____

3. Take a pinwheel and hold it over the jet of steam rushing out. (Caution: Do not put your hand over the jet of steam. The steam is very hot and can give you a bad burn.) What happens to the pinwheel?____________________ Why?

____

4. How has steam been used in the past as a form of energy?

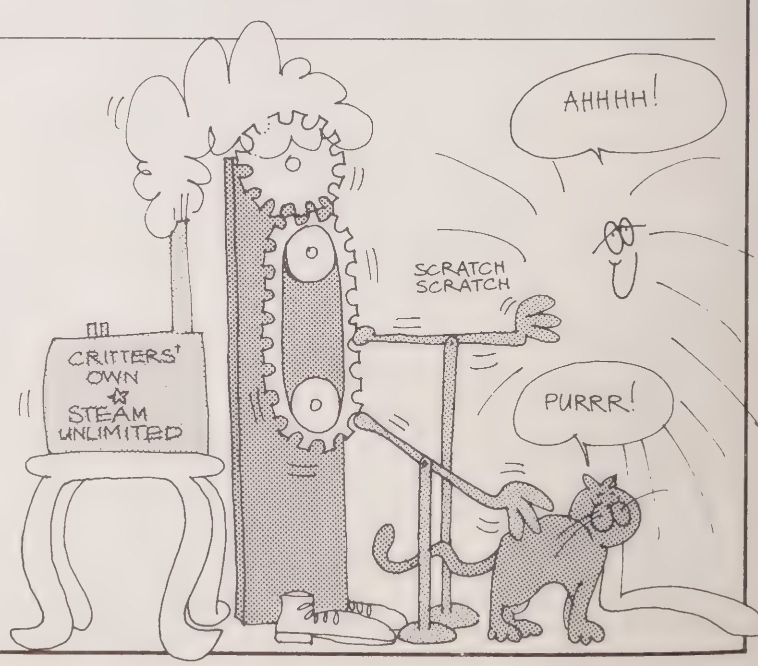
____

____

5. How is steam presently used as a form of energy?

____

____



Notes

The purpose of this activity set is to have students recognize that steam can be made to do work, for example, to turn turbines to produce electricity.

Steam is simply the product that results from the vaporization of water. When water is heated to produce steam within a closed container, a great deal of pressure is built up. This pressure, caused by the steam, can be released slowly through a valve, thus producing a source of energy which can do work (make things move or turn). This basic principle explains the operation of steamboats and steam locomotives.

Many turbines in Ontario Hydro's power plants spin under the force of falling waters from Ontario's rivers and waterfalls. There is, however, a greater number of much larger turbines spun by the force of super-hot jets of high-pressure steam in modern thermal-electric and nuclear generating stations. Thermal stations are fired by coal, oil, or natural gas. Vast amounts of fossil fuels are required to produce the steam to turn the turbines to generate electricity. For example, a 2000 MW (megawatt) thermal-electric station may burn up to 813 t (tonnes) of coal an hour, enough to keep a home furnace operating for more than 100 years.*

Figure J1.7 — Ontario Hydro Generating Stations

Source: Ontario Hydro Annual Report, 1975.

*Ontario Hydro, *Kilowatts from Steam* (Toronto: Public Relations Division, Ontario Hydro, n.d.), p. 6.

Due to rising coal and oil costs and because of the successful operation of the Pickering plant, nuclear power stations have become more attractive. There are however advantages to building fossil-fuelled plants, including lower capital costs and improvements in technology. Engineers now squeeze 2½ times more electricity from coal and oil than they could 40 years ago. Ontario Hydro has incorporated many technological advances, involving automation, high pressure, high temperature steam and larger units into its thermal plants to promote higher efficiency. With even larger units, greater efficiency and cost savings are expected.

Source: Ontario Hydro, *Kilowatts from Steam* (Toronto Public Relations Division, Ontario Hydro, n.d.), pp. 6 and 8.

Follow-up Activities

1. Have students make a diagram comparing the two methods of producing electricity – that in which turbines are turned by falling water and that in which they are turned by steam. Have them determine through discussion which would appear to use the least energy over all.

2. Have students find out how nuclear generating stations produce steam.

3. Ask students to name some other examples of steam doing work (e.g., steam cleaning of car engines).

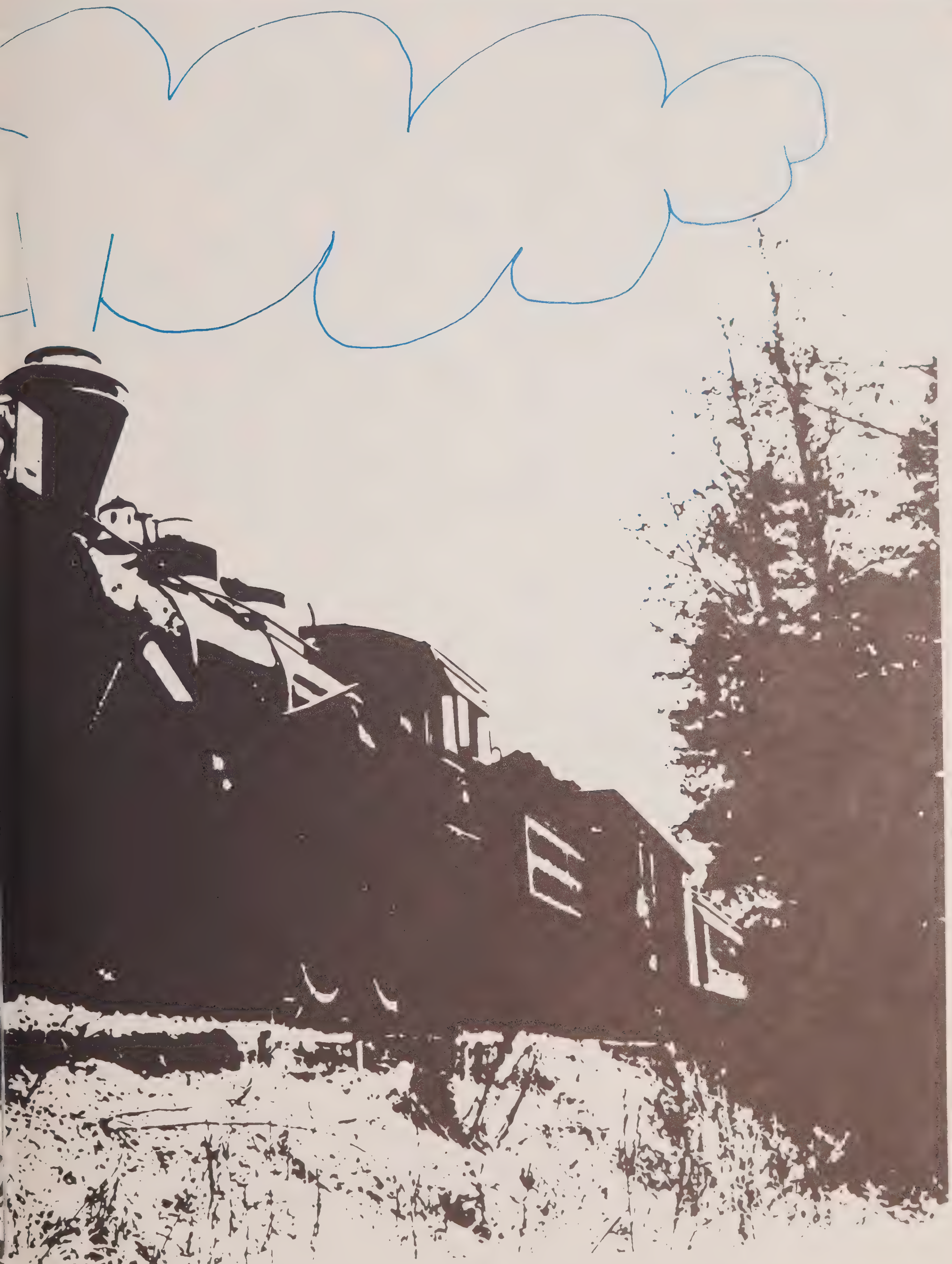
4. Ask them what the difference is between steam and water vapour.

Related Ideas

1. Have students make a mural showing the use of steam in the past, present, and future.

2. Have students construct a model of a steam-powered boat. A small test tube can serve as the steam boiler. A one-hole stopper is inserted into the test tube. A piece of glass tubing with one end shaped like a jet (as illustrated on the activity sheet) should be placed in the hole of the rubber stopper. The test tube is mounted horizontally on the boat and high enough so that a candle can be placed under the test tube. The jet should point to the back of the boat. When water is heated in the test tube, the steam rushing out the jet of the glass tubing will propel the boat forward.

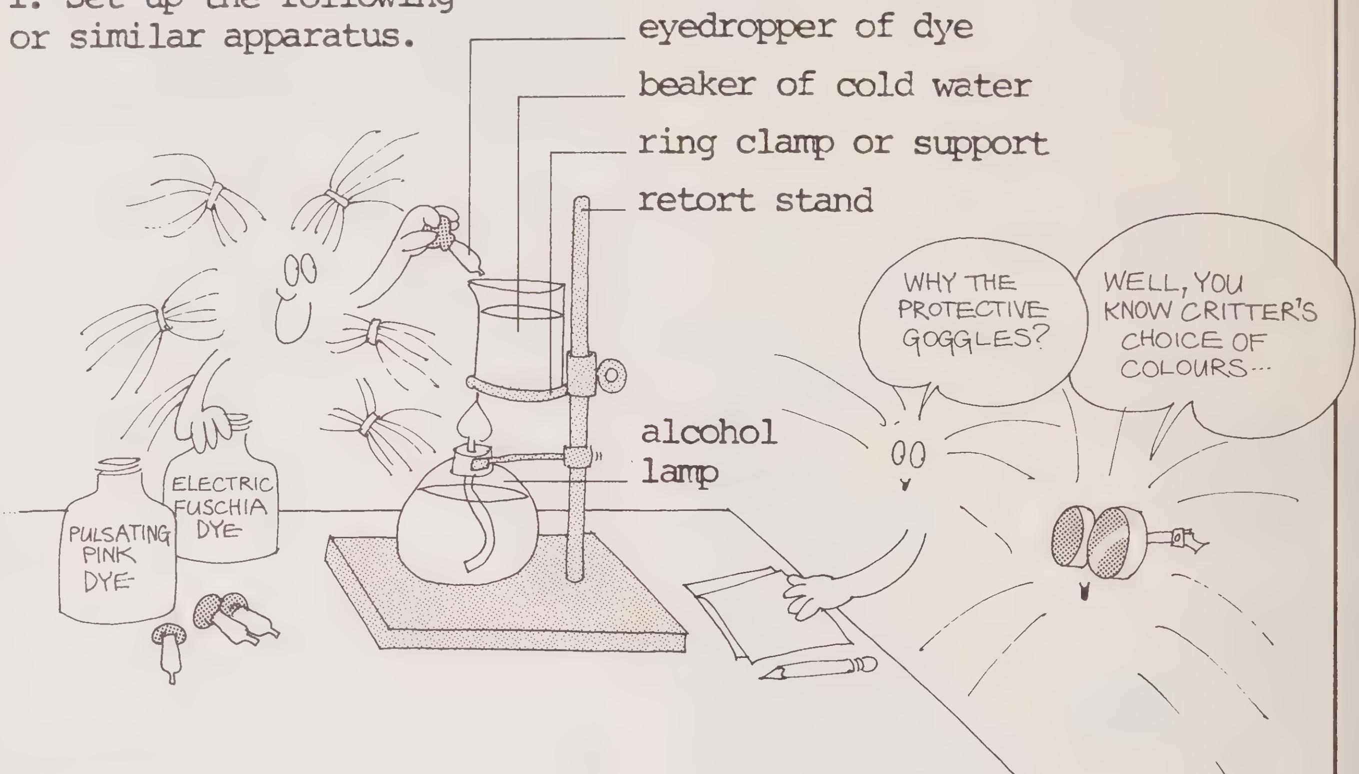
3. Have students find out:
a) how steam is used in industrial processes;
b) how steam is used in cooking;
c) why the steam locomotive was replaced by the diesel locomotive.



Name:

Heat Moves in Water

1. Set up the following or similar apparatus.



2. Begin to heat one side of the beaker of water by placing the flame of an alcohol lamp (or other heat source) under that side.

3. After about 3-5 min, place a couple of drops of dye (or food colouring) in the bottom of the beaker on the side being heated. What begins to happen to the dye?

____

4. The movement of the dye in a circular pattern shows what is called a "convection current". From where you are sitting, did the convection current produced in this activity move clockwise or counter-clockwise?____________________ In what direction would the convection current move if the other side of the beaker had been heated first?______________________________

5. Why does the dye move downward on the side not being heated and upward on the side being heated?

6. Some homes are heated by a hot-water heating system. Using materials in the library to help you, make a diagram to show how a hot-water heating system works. Make sure you indicate the direction of movement of the hot water. Is a convection-like pattern set up? Explain your answer.

Notes

The purpose of this activity set is to have students become aware of how heat is transferred through water.

The convection current is a very important mechanism in the transfer of heat, not only in water but also in air. Warm water is displaced upward due to cold water falling. Gravity causes the cold water, which has a greater density than the warm water, to fall. The process of convection, therefore, depends on gravity. This pattern also occurs with cold air and warm air masses. Sometimes convection currents are referred to as "density currents".

In terms of large water and air masses, convection is extremely important. It allows global circulation of warm and cold air as well as heat exchange within the oceans. Illustrations of this circulation of air and water on a global scale can be observed by examining most atlases.

When preparing the apparatus for this activity, you may also consider doing a demonstration experiment for the students using potassium permanganate (if available). Put a few crystals of potassium permanganate on the bottom of the beaker once you have started to heat the water. The colour disseminated from the crystals will indicate the movement of the water in a convection-like manner. Figure J1.8 shows the convection-like movement of the water in the beaker.

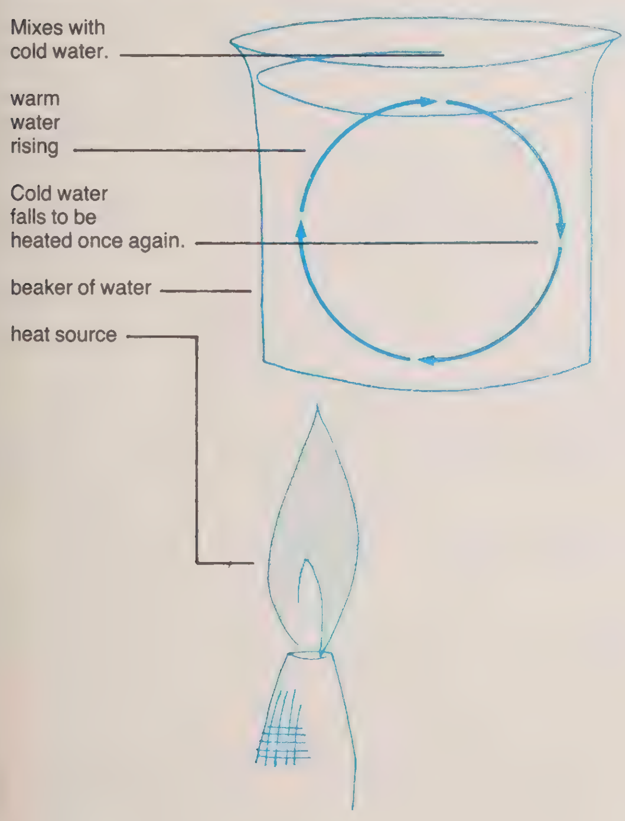
Caution: Potassium permanganate is a poisonous substance and should not come in contact with the mouth. It is recommended that it be handled only by you.

Warn students about the danger involved in using alcohol lamps. Tell them that:

1. Long hair should be kept away from the flame.

2. The alcohol lamp should be placed in an alcohol-lamp holder in the centre of the table so that it is not knocked on the floor. (Holders are available from science supply companies.)

Figure J1.8: Convection Currents



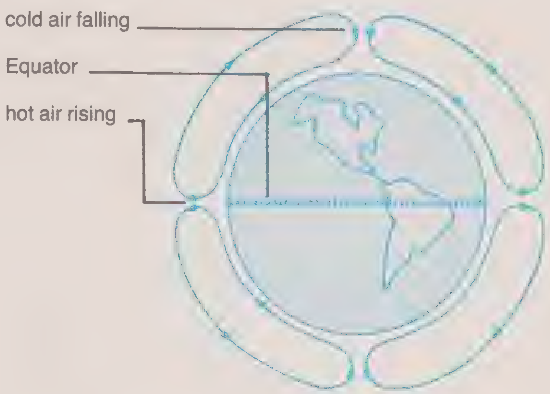
Follow-up Activities

1. Have students obtain an atlas and turn to a world map that has the water currents marked on it. See if they can suggest whether there are convection current patterns in the oceans and why they are useful.

2. Have students make a diagram of a hot-water heating system in a home or an apartment. They can label the changes in the temperature of the water as it moves up through the pipes and back to the hot-water heating system in a convection-current-like pattern.

3. Demonstrate the relation of convection currents to the movements of air masses on the face of the globe.

Figure J1.9: Movement of Air Masses



Related Ideas

1. Have students look for convection currents in the air in the classroom. This may be done by clapping two chalkboard brushes together near an open window. The movement of the chalk particles can be observed.

2. Ask students how convection is related to bonfires and fireplaces, and how they work.

3. Heatilators are built into fireplaces being constructed in new homes. Have students find out the purpose of a "heatilator".

4. Have students consider whether there is a convection current around a person's body. What effect does a tight collar have on air flow?

5. Have students find out through research if there is convection on a space ship travelling in outer space.

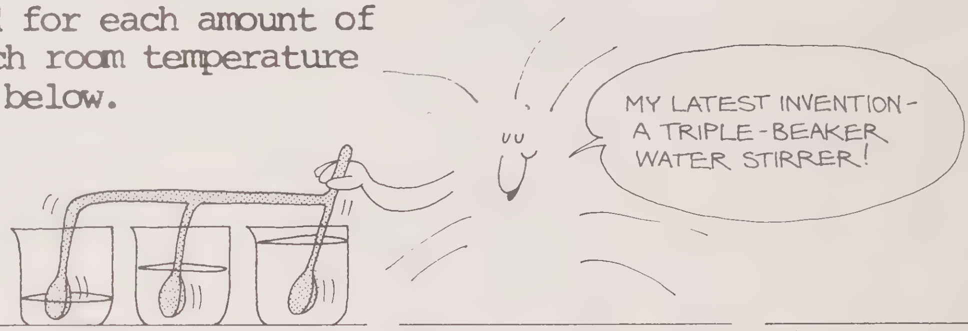
Name:

Heat Energy in Water

1. Obtain three containers (glass Pyrex beakers). Put 100 mL of water in one, 200 mL in another, and 300 mL in the third.

2. Record the initial temperature in the chart and heat each of the three containers of water to 50°C using a constant heat source. Stir each container while heating. Record the time required for each to reach a temperature of 50°C. Record the times in the chart below.

3. Let the beakers of water cool to room temperature. Make sure the beakers are stirred during the cooling process. Record the time required for each amount of water to reach room temperature in the chart below.



Volume of Water	Initial Temperature of Water (°C)	Time Required to Heat up to 50°C	Time Required to Cool to Room Temperature
100 mL			
200 mL			
300 mL			

4. Which volume of water took the greatest amount of time to heat? Why?

5. Did any one container of water cool back to room temperature faster than the others? Why or why not?

6. Look at your hot-water heater at home or the one at school to determine its volume in litres. (Remember 1 gallon = 4.54 L.) The water heater contains______L.

How many times larger is the water heater than the 100 mL of water you worked with?__________

How long did it take you to heat 100 mL of water to 50°C?
________min

Would it take a long time to heat all the water in the hot-water heater?______Would it require a lot of heat energy?______

Notes

The purpose of this activity set is to have students become aware of the amount of heat energy required to raise the temperature of water. As well, they should be made aware of the large quantities of heat that water can hold, and the ability of water to hold this heat for a considerable length of time. In the notes that follow, the cost of heating water is discussed. You may wish to discuss some of this information with your students.

Water is an ideal storage medium of heat energy. Lakes and oceans are able to hold large quantities of heat. Water is currently the medium used to store the heat absorbed by the solar panels in solar-heated homes, although antifreeze is being used more and more frequently.

In this activity, students should recognize that the larger the volume of water, the longer it will take to heat the water to a desired temperature, since more heat energy is required as the volume of water increases. When water begins to cool, the larger volume of water will take longer to cool to a desired temperature, since there is more heat in it.

This activity can be related quite nicely to the hot-water heater in the home. Students can easily appreciate that a great deal of heat energy is needed to heat the water in the hot-water tank to 50°C, as suggested at the end of the activity sheet.

The actual amount of energy required to heat a volume of water to a desired temperature can be calculated. To raise the temperature of 1 L of water 1° requires 4.2 kJ (kilojoules). Therefore, if 1 L of water is to be heated from 5°C to 50°C, it would require 189 kJ or 0.189 MJ (megajoules), which is calculated as follows:

$$1\text{ L} \times 45°\text{C} \times 4.2 \frac{\text{kJ}}{\text{L}\cdot°\text{C}} = 189\text{ kJ}$$

The answer of 0.189 MJ could be changed to kW•h of electricity used (1 kW•h = 3.6 MJ). Therefore, 0.189 MJ would represent 0.053 kW•h of electricity used, if electricity was the heating source.

On the average
– 1 gallon of # 2 heating oil will heat approximately 110 gallons or 500 L of water.

– 1 cubic foot of natural gas will heat approximately 1.2 gallons or 5.5 L of water.

– 1 kW•h of electrical energy will heat approximately 4 gallons or 18 L of water.

Source: Ontario, Ministry of Education, *Energy in Society: A Resource Guide for Teachers* (Toronto: Ministry of Education, Ontario, 1978), part 4, p. 30.

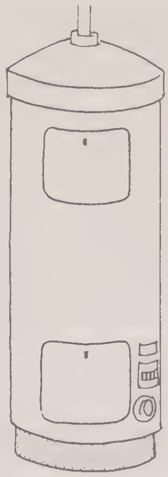
Assuming 100 per cent conversion of energy:
– 1 gallon of #2 heating oil supplies approximately 177 MJ.

– 1 cubic foot of natural gas supplies approximately 1.116 MJ.

– 1 kW•h of electricity supplies approximately 3.601 MJ.

If we know the cost of a kilowatt hour of electricity, a gallon of #2 heating oil, or a cubic foot of natural gas, we can determine the cost of heating the water in a home, if the amount of hot water used per day, per week, etc., is recorded. Since the cost of oil, natural gas, and electricity is constantly changing, figures have not been supplied.

It is interesting to note that the thermostats on many hot-water heaters are set at about 70°C. However, when does one really use water that hot? Would not water at 60°C be sufficiently hot for use in our homes? The minimum temperature for the operation of a dishwasher is about 60°C, due to the breakdown temperature of detergents now in use. If you do not have a dishwasher, you may even be able to use water at a lower temperature than 60°C.



During the winter of 1975-76, Ontario Hydro conducted a study on lowering the temperature of the hot-water supply in a ninety-eight unit electrically heated senior citizens' building in Mississauga. When the hot-water temperature was lowered from 71°C (160°F) to 49°C (120°F), an energy saving of 25 per cent was realized.*

Besides lowering the hot-water temperature, we can have hot-water pipes insulated in order to save energy. Insulation helps prevent heat from escaping from the water through the pipe. Students can gain an appreciation of insulation by observing the thermos bottle and its ability to keep heat in or out. The length of hot-water pipes is a third factor that affects energy use. The longer the pipe, the more heat energy is lost.

Follow-up Activities

1. Have students fill a thermos with hot water (70°C). Have them put the same amount of water at 70°C in an open container. The temperature of each container should be checked periodically to determine what is happening to the temperature. This will help students appreciate the value of insulation.

2. Have students determine how hot the water is in their hot-water heater at home by placing a thermometer in the hottest water they can get from the hot-water tap near the heater.

3. Have students ask their parents to check the setting of the thermostat on the hot-water heater at home and to determine with them the highest hot-water temperature they need. If the thermostat is set higher than this, they can call the utility company (gas, oil, or electricity) to find out how to lower the thermostat. (A similar activity can be conducted at school.)

4. Have students do a research project on solar heating. They should find out the use to which water or other liquids are put in solar heating.

5. Ask students what other materials could be used for storing and transporting energy.

Related Ideas

Ask students the following questions:

1. What are the uses of hot water in the home? Which use(s) take(s) up most of the hot water used in the home?

2. When water is mixed, which should be added first – hot or cold? Why?

3. Why does it get warm when it snows?

4. How do the Great Lakes moderate the climate of the regions around them?

*Ontario Hydro, *Energy Management for the Conservation of Electricity* 12, (February 1977): 2

Name:

Baths and Showers

1. Do you usually bathe or shower?____________________

2. How many times per week do you bathe or shower?____________________

3. Have you any idea how much water you use when you bathe or shower? Find out whether bathing or showering uses the most water: The next time you decide it's time to get clean, take a bath. Run the bath to a suitable level in the bathtub. Measure the depth of the water in the bathtub and the length and width of the bathtub in centimetres. Let's assume that the bathtub is almost rectangular in shape. Its volume, therefore, would be $l \times w \times d$, and the volume of water you used in your bath would be: length (_____cm) $\times$ width (_____cm) $\times$ depth of water (_____cm) = ______cm^3.

4. 1 L of water contains 1000 cm^3 of water. Calculate how many litres of water you used, as follows:
______$cm^3 \div 1000$ = _____L.

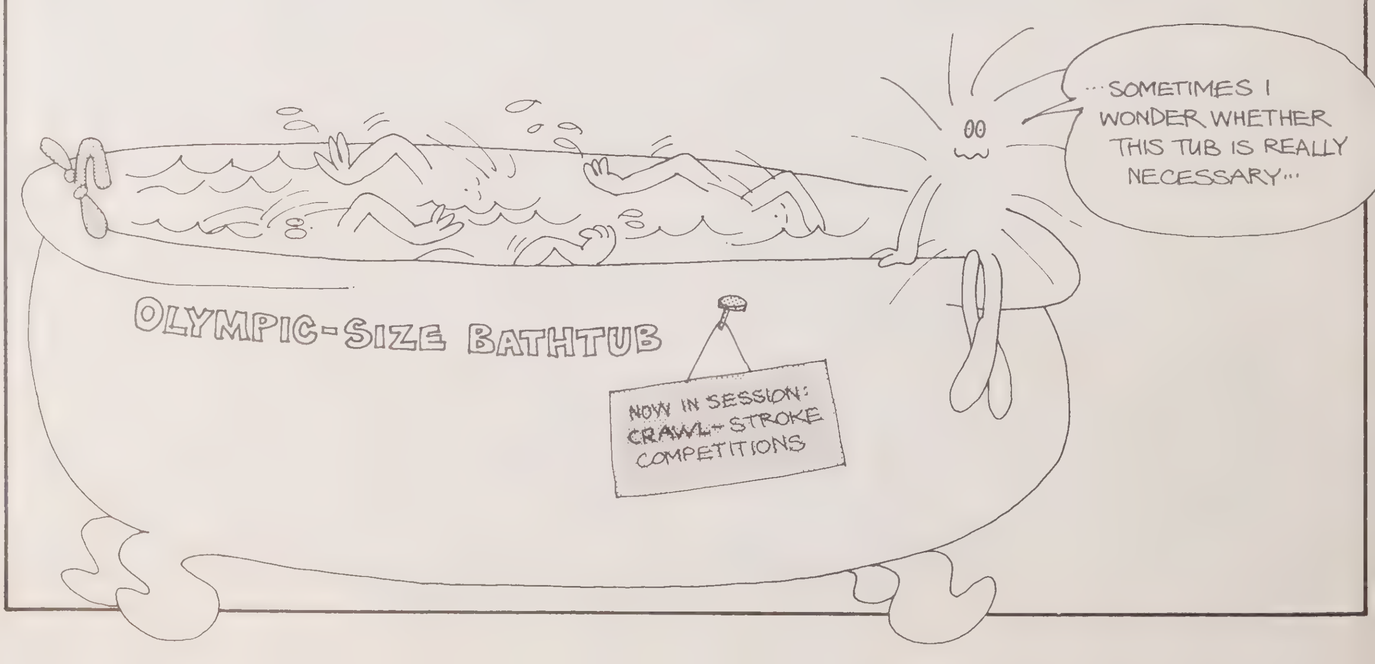
5. The next time you shower, leave the plug in. When you have finished showering, repeat the procedure above to determine how many litres of water you used in showering. Number of litres of water used in showering is______L.

6. Did you use more water bathing or showering?____________________

7. In which do you use hotter water, bathing or showering?

____

8. Under what conditions would more water be used in a bath? In a shower?



Notes
The purpose of this activity set is to have students compare the amounts of water used in showering and bathing.

When students complete this activity set, they should discover that the shower takes normally about one-half the water a bath would. The normal shower uses about 45.4 L of water (10 gallons).* The controversial issue in determining whether the bath uses more water than the shower is the time factor. It is assumed that a reasonable amount of time is spent in the shower.

It is also possible to calculate the amount of water flowing from the bathtub faucet in a home over a period of time. Simply let a volume of water flow into a container (e.g., a pail) for a period of 15 s. Measure the volume of water and multiply by four to give the volume of water flow over 1 min. By determining this, and calculating the length of time you spend in the shower, you can find out how much water you are using.

In the calculations on the student activity sheet, it is assumed that the tub is rectangular. This method is approximate and will give the students a good estimate of the amount of water used when showering or bathing.

A more accurate method of finding the volume of water used in taking a shower or bath would be to use a water meter, if one is available. In this method, the meter is read before and after the bath or shower to determine the water used.

Water meters may be gauged in gallons or litres. The conversion factor is 1 gallon=4.54 L.

Follow-up Activities
1. Have students measure the rate of water flow from the bathtub faucet to determine the number of litres per minute.

2. Have students make a graph showing the number of times each student in the class showers or bathes during a week. Discuss afterwards an optimal number of baths or showers. Have each student find out how many times other members of his/her family bathe or shower, and determine the average number of baths or showers taken by family members. In order to calculate this, each student needs to keep a record of the numbers of baths and showers that each member of his/her family takes over a certain time period.

3. Ask students to find out what other ways water is used excessively in the home (e.g., running dishwasher with only half a load). Have them determine the amounts of water used in each instance where possible, and suggest ways in which some of this water could be conserved.

*Ontario Hydro, *Some Helpful Ideas to Conserve Hot Water,* Publication 984-0316:5. Toronto: Ontario Hydro, n.d.

Related Ideas
Students can explore any or all of the following question-projects:

1. Why do we wash? What is meant by "clean"?

2. How do the bathing habits of people in other countries (e.g., Japan) differ from those common in Ontario?

3. What is a "sauna bath"?

4. What is the difference between "hard" and "soft" water? What is the purpose of a water softener?

5. In what other ways besides cleaning ourselves is water used for cleaning around the home (e.g., washing dogs, cars)?

6. What are some of the different types of soaps and shampoos? Conduct a consumer study on soaps and shampoos to determine their ability to produce suds in cold water or hot water.

Name:

Don't Drip!

1. Adjust a cold-water tap to allow water to drip at the rate of one drop per second.

2. Place a container under the tap to catch the dripping water.

3. Allow the tap to drip for about 15 min. Take the water that has been caught in the container and determine its volume. You may do this by pouring it into a graduated cylinder. Record your answer. The volume of water which has dripped in 15 min is ____ mL.

4. Determine how much water would be wasted if a tap were allowed to drip at the rate of one drop per second for:

a) 1 h ____________________

b) 8 h ____________________

c) 1 day ____________________

d) 1 week ____________________

e) 1 month ____________________

5. Determine how much water would be wasted if a tap were allowed to drip at the rate of two drops per second for:

a) 1 h ____________________

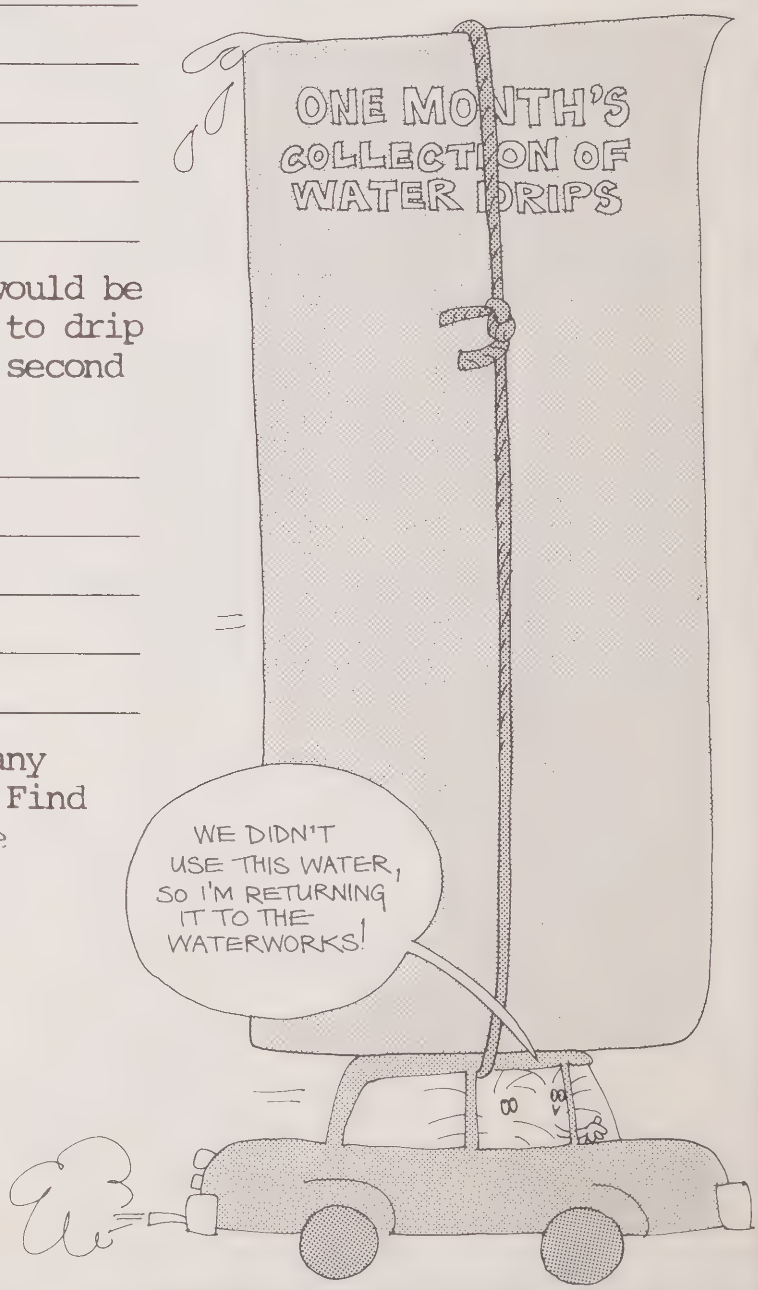
b) 8 h ____________________

c) 1 day ____________________

d) 1 week ____________________

e) 1 month ____________________

6. Check to see if you have any taps in your home that drip. Find out how a dripping tap can be repaired.



Notes

The purpose of this activity set is to have students recognize the amount of water, and thus energy, that is wasted from a dripping tap.

Quite often there are taps that drip in the home because they are not shut off properly or because the tap itself is faulty. Not very many people are aware of the amount of water that can be wasted by a dripping tap. A tap dripping at the rate of one drop per second will waste approximately 795 L of water in a month. The amount of water wasted, if related to the water-sewage bill, begins quickly to add up in terms of dollars. If the dripping tap is hot water, the money required to pay for the electricity, oil, or gas used to heat the water in the hot-water tank is also wasted. If the approximate volume of hot water used per month can be determined, an approximate dollar cost can be calculated for hot water wasted because of a dripping tap, based on the following figures:

> The average wattage of a water heater in a home in Ontario is 4500 watts. Approximately 500 kW•h (kilowatt hours) of electricity are used per month by a hot-water heater at a cost of $12.50.

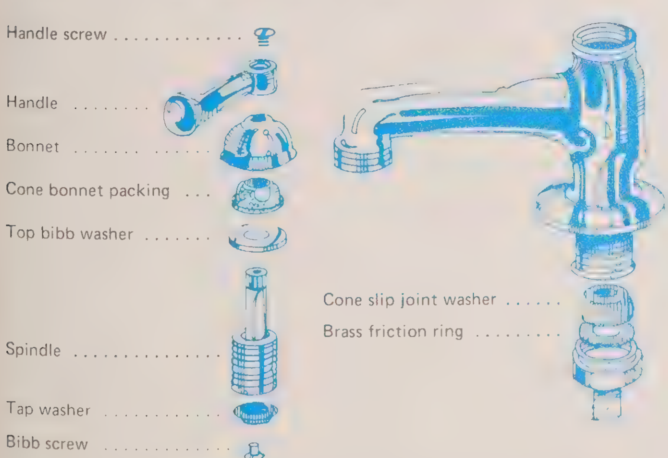
Source: Ontario Hydro, *How You Use the Electricity You Use*, Publication 984-0343:1 (Toronto: Ontario Hydro, 1975).

Thus, by calculating the approximate number of litres of hot water used in a month, you can determine the cost of heating 1 L of hot water.

If the number of litres of hot water wasted by a dripping tap is calculated and multiplied by the cost required to heat 1 L of water (use the cost for 1 gallon of heating oil, 1 cubic foot of natural gas, or 1 kW•h of electricity and the amount of water heated – refer to the notes to Activity Set 9), the actual dollar value wasted by a dripping hot-water tap can be determined. (If this calculation seems too complex, use an equivalent figure such as $12.50 for either electricity, gas, or heating oil.)

Figure J1.10 shows a cut-away view of a water tap. A tap usually leaks if, when the spindle is turned down by the handle, the washer or disc attached to the bottom of the spindle does not press tightly against a smooth finished ring or ground seal. To remedy the problem in most instances, the washer has to be replaced.

Figure J1.10: Cut-Away View of a Water Tap



Source: Ontario, Ministry of Education, *Energy in Society: A Resource Guide for Teachers* (Toronto: Ministry of Education, Ontario, 1978), part 4, p. 21.

Follow-up Activities

1. Have students calculate the amount of water wasted by a dripping tap over an hour, day, week, and month if the rate of dripping is three drops per second.

2. Have students repair, with their parents' help, a dripping faucet, if they have one.

3.a) Have students determine the ratio of hot water wasted due to a dripping tap to the total amount of hot water used in one day. The amount of hot water used could be determined in a number of ways. If the activity involved uses only hot water (e.g., washing dishes in a dishwasher), the water meter could be used. Since cold water enters the hot-water tank as hot water leaves, the difference in meter readings before and after use will reveal the amount of hot water used. (Remember that water from a hot-water tap has been heated even if it starts off cold.)

If a mixture of hot and cold water is used in a job, the cold water can be run first and its volume measured. The hot water is then run until the desired temperature is reached. Then the total volume is measured. The volume of hot water can then be determined by subtraction.

b) The amount of hot water used per day could be projected for a week, a month, or a year. Assume that the average number of kilowatt hours required to operate a hot-water heater over a month is about 500 and have students calculate the number of kilowatt hours required to heat the wasted hot water.

c) As outlined in Activity Set 6, it takes 12 000 L of water falling 30 m to produce 1 kW•h of electricity. Students can determine how much water had to fall to produce the electricity required to heat the wasted hot water.

4. Have students determine the cost of heating the wasted hot water in 3(b) above, if each kilowatt hour of electricity used costs 2.35 cents.*

Related Ideas

Have students explore the following questions/projects:

1. What are the shapes of droplets of water? Of other liquids?

2. How can raindrops or hail cause damage to crops?

3. Using an eyedropper, drop drops of water from various heights on a piece of blotting paper, cardboard, or dusty wood. Observe and record the shape and size of the splashes. Tilt the cardboard and see how this alters your findings.

4. What happens to matter when it is heated? When it is cooled?

5. When are taps or fountains allowed to run without being used in your school or at home? (For example: Is a fountain left running all the time in school? Do you let a lawn sprinkler run for longer periods of time than necessary?) What can you do to help conserve our water?

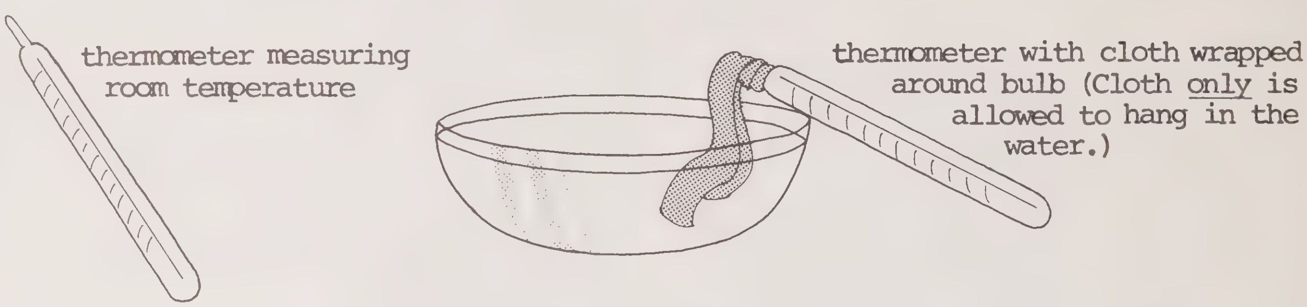
*Energy, Mines and Resources Canada, *100 Ways to Save Energy and Money in the Home* (Ottawa: Publishing Centre, Supply and Services Canada, 1978), p. 96.

Name:

Water Is Cooling!

1. Obtain two Celsius thermometers. Leave one thermometer on your table to measure the room temperature.
Room temperature is_____ °C.

2. Take the other thermometer and wrap a small piece of cloth around its bulb with an elastic. Allow the piece of cloth to hang loosely from the end of the thermometer. Take a container of water at room temperature (the same temperature you measured in activity 1) and moisten the cloth that is fastened around the thermometer with the water. Allow the cloth to hang in the container of water as shown in the following illustration:



Record the temperature shown on the thermometer after 5 min: ______ °C; after 10 min:______ °C. Is this temperature the same as the temperature recorded in activity 1?______. Try to explain why the temperatures are not the same.

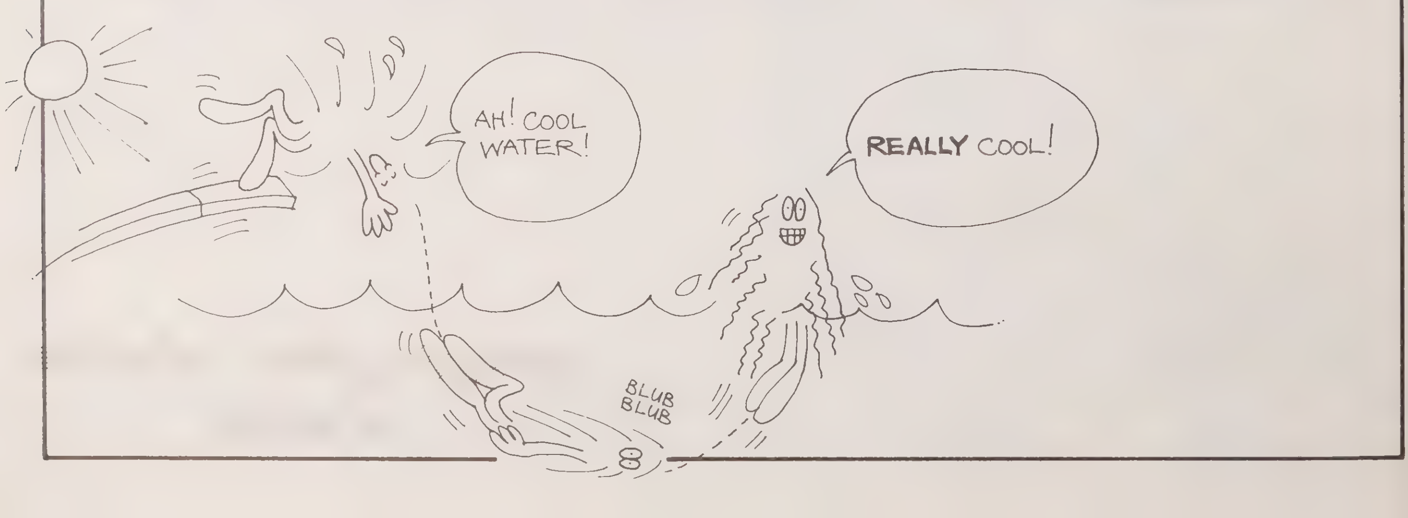
____

____

Why do you feel cool when you first step out of a pool?

____

Is heat energy being lost or gained?______________________________



Notes

The purpose of this activity set is to have students recognize that when water evaporates, a heat-energy change occurs.

In this activity, students have the opportunity to construct a simple wet- and dry-bulb hygrometer system. Even though the temperature of the air and the water is the same, the thermometer with the wet cloth around it will show a lower reading. This can be explained by the fact that the water rising up through the cloth around the bulb of the thermometer is evaporating. The evaporation process results in a heat loss or cooling effect, therefore giving a lower temperature reading. The water that evaporates gains the heat, since evaporation, in order to occur, requires a heat-energy input. This also explains why one feels cool at first when stepping out of a pool. As it evaporates, the water on the skin extracts the required heat energy from the body, thus making the skin feel cool. The amount of evaporation depends upon the amount of water vapour in the air (the humidity). The more water vapour in the air, the less evaporation. The wet- and dry-bulb hygrometer gives weather forecasters a reading of the relative humidity of the air, or the percentage of water vapour in the air.

Follow-up Activities

1. Have students determine the relative humidity in the air each day for a week and for a month. A conversion chart for determining the relative humidity is included in Figure J1.11.

2. Have students research how a dehumidifier works and what its purpose is. As well, you may have them discover how an air conditioner works.

3. Students may research and discuss why and how animals perspire (e.g., a dog pants).

4. Have students discover how water is used as a cooling agent in industry (e.g., it is used as a cooling agent for furnaces at Stelco).

5. Have students find out how water is used in food processing.

Related Ideas

Have students explore the following questions:

1. What kind of changes do we make in the clothing we wear at different times of the year?

2. What really happens to the body when perspiration takes place (e.g., loss of body fluid and salt)?

3. Several modern conveniences such as air conditioners help to keep people cool when it is hot. What other methods do people in places such as Africa or India use to keep cool?

Figure J1.10: Relative Humidity Conversion Chart.

	Dry-Bulb Temperature (°C)																				
Wet-Bulb Temperature (°C)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	10																				
2	15	9																			
3	24	18	12	7																	
4	34	27	21	15	10	6															
5	44	36	29	23	18	13	8														
6	55	46	39	32	26	20	15	11	7												
7	66	56	48	41	34	27	23	18	14	10	6										
8	77	67	58	50	42	36	30	25	20	16	12	9	6								
9	88	78	68	59	51	44	38	32	27	22	18	14	11	8	5						
10	100	91	78	69	60	53	46	40	34	29	24	20	17	13	10	8					
11		100	89	79	70	61	54	47	41	36	31	26	22	19	15	12	10				
12			100	89	79	71	63	55	49	43	37	32	28	24	20	17	14	12	5		
13				100	90	80	71	64	57	50	44	39	34	30	26	22	19	16	13	7	
14					100	90	81	72	65	58	51	46	40	36	31	28	24	21	18	15	9
15						100	90	81	73	65	59	53	47	42	37	33	29	26	22	19	17
16							100	90	82	74	66	60	54	48	43	39	34	31	27	24	21
17								100	91	82	74	67	61	55	49	44	40	36	32	28	25
18									100	91	83	75	68	62	56	50	46	41	37	33	30
19										100	91	83	76	69	62	57	51	47	42	38	35
20											100	91	83	76	69	63	58	52	48	43	39
21												100	92	84	77	70	64	58	53	49	44
22													100	92	84	77	71	65	59	54	50
23														100	92	84	78	71	65	60	55
24															100	92	85	78	72	66	61
25																100	92	85	78	72	67
26																	100	92	85	79	73
27																		100	93	86	79
28																			100	93	86
29																				100	93
30																					100

Source: William A. Andrews, T.J. Elgin Wolfe, and John F. Eix, *Physical Science* (Scarborough, Ont.: Prentice-Hall of Canada, 1978), p. 110.

Glossary

Forms of water. Refers to the three states of water: solid, liquid, gas.

Gas and vapour. Quite often these two words are confused. "Gas" refers to the naturally occurring state of such substances as oxygen, hydrogen, nitrogen, etc. "Vapour" refers to the change of form of a substance usually produced by heating the liquid form of the substance to the boiling temperature. At the boiling temperature, vaporization occurs. (For example: when water is heated to 100°C, vaporization occurs.)

Global circulation. Refers to the movement of masses of cold and warm air or cold and warm water on the earth's surface. Through convection the warm and cold masses mix, thus allowing heat exchange. In the case of air this is accomplished by the displacement of warm air by the heavier cold air. The same process also occurs in water.

Lifestyle. "Our lifestyle" refers to our living habits. Are we wasteful with money? Are we neat and tidy? Do we bathe everyday? Do we leave lights on instead of turning them off? Do we heat a full kettle of water when a half kettle would do?

Litre. The litre is the metric unit of capacity. Note that the symbol for litre is now "L".

Making water clean. Making water suitable for human consumption. This is usually referred to as making water potable (drinkable).

Pollution of water. The addition of foreign substances into water which make it no longer suitable for human use (potable).

Properties of water. The characteristics of water such as colour, odour, density, boiling point, freezing point, etc.

Steam for power. Steam can be used to perform work. It was first harnessed to drive locomotives and boats many years ago.

Water-energy conservation. Water is referred to as a potential source of energy. By conserving water, we thus conserve energy.

Water is cooling. When water disappears from the surface of an object or our body through evaporation, there is an accompanying loss of heat.

Water per capita. The amount of water used by the average person over a period of one year.

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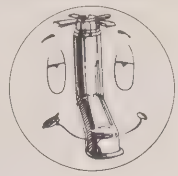
Splash

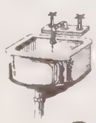
THIS GAME'S
ALL WET!

MARKERS

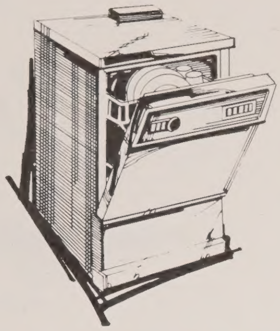
	99	98	You took a bath with too much water. 
81	82	DRAW A CARD	84
80	79	78	DRAW A CARD
61	62	63	64
60	59	58	57
41	42	DRAW A CARD	44
DRAW A CARD	39	38	37
21	22	23	DRAW A CARD
DRAW A CARD	19	18	17
1	2	DRAW A CARD	4

To make the gameboard, photocopy pages 35 and 36. Then cut along the outside lines and paste the two parts of the gameboard together on a piece of cardboard.

Cut out the markers and paste onto cardboard circles.

96	95	94	93	92	You washed a half load of clothes in the washing machine. 
85	86	87	88	DRAW A CARD	90
76	75	DRAW A CARD	73	72	71
You took a quick shower instead of a bath. 	66	67	68	69	DRAW A CARD
56	DRAW A CARD	54	DRAW A CARD	52	51
45	46	You used collected rain water to water the garden. 	48	49	50
You fixed a dripping tap. 	35	You used a bucket of water to wash the car instead of the hose. 	33	DRAW A CARD	31
25	26	DRAW A CARD	28	29	30
16	DRAW A CARD	14	13	You heated a whole kettle of water to make one drink. 	11
5	You jammed the drinking fountain at school. 	7	8	DRAW A CARD	10

You washed a few dishes in the dishwasher instead of the sink.

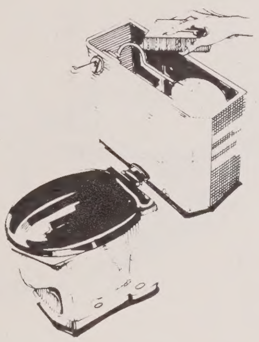


You washed your hair in the lake.

You watered the lawn with the hose and left it on too long.

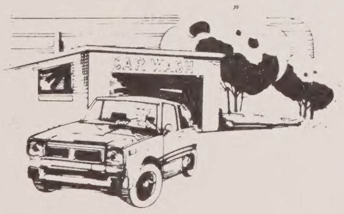
You made yourself a hot drink, using just enough water in the kettle for one cup.

You put a brick in the toilet tank.

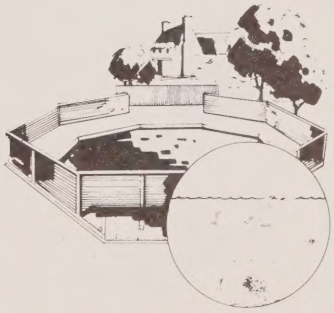


The outhouse was moved away from the lake.

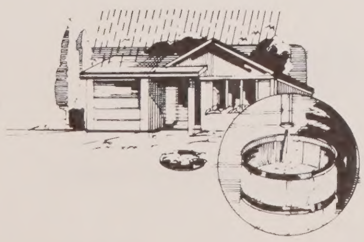
Your mother took the car through the car wash.



A lot of grass and sand were thrown into the pool and now it has to be cleaned out.



You save rain water to water the garden.



One of your friends jammed the drinking fountain at school and you didn't try to unjam it and turn it off.

Go back________________

Advance________________

Advance________________

Go back________________

Go back________________

Advance________________

Go back________________

Advance________________

Advance________________

Go back________________

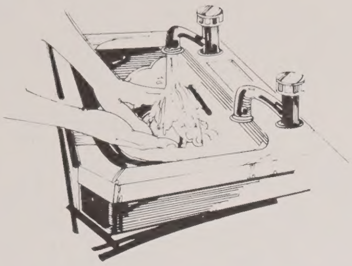
Go back________________

Go back________________

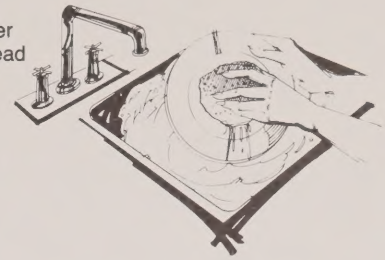
Advance________________

Go back________________

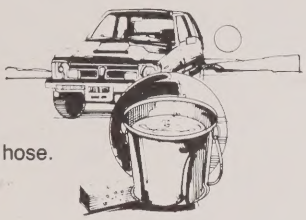
You washed your hands in running water.



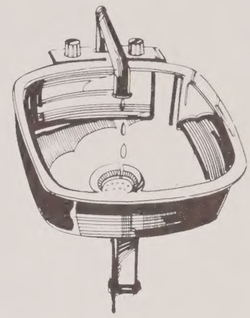
You washed the supper dishes in the sink instead of in the dishwasher.



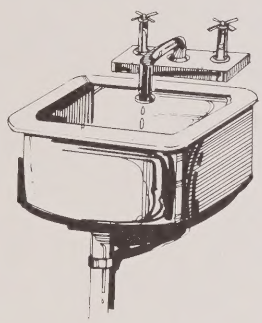
You washed the car with a bucket of water instead of the hose.



You left the tap dripping after you brushed your teeth.

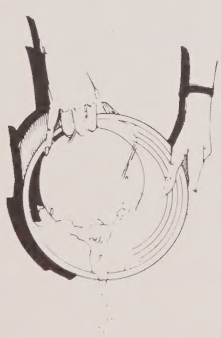


You turned off a dripping tap.

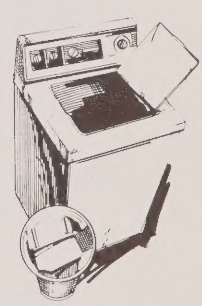


You took a quick shower last night instead of a bath.

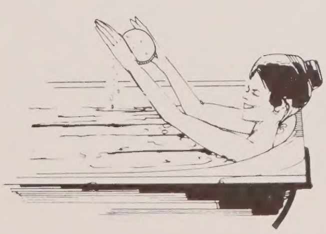
You poured the dirty dishwater into the lake.



You washed the clothes in the washing machine and you only had a half load.



You took a bath using lots of hot water.



You washed the car with the hose.

Advance__________

Go back__________

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